

POCUS

Point of Care Ultrasound

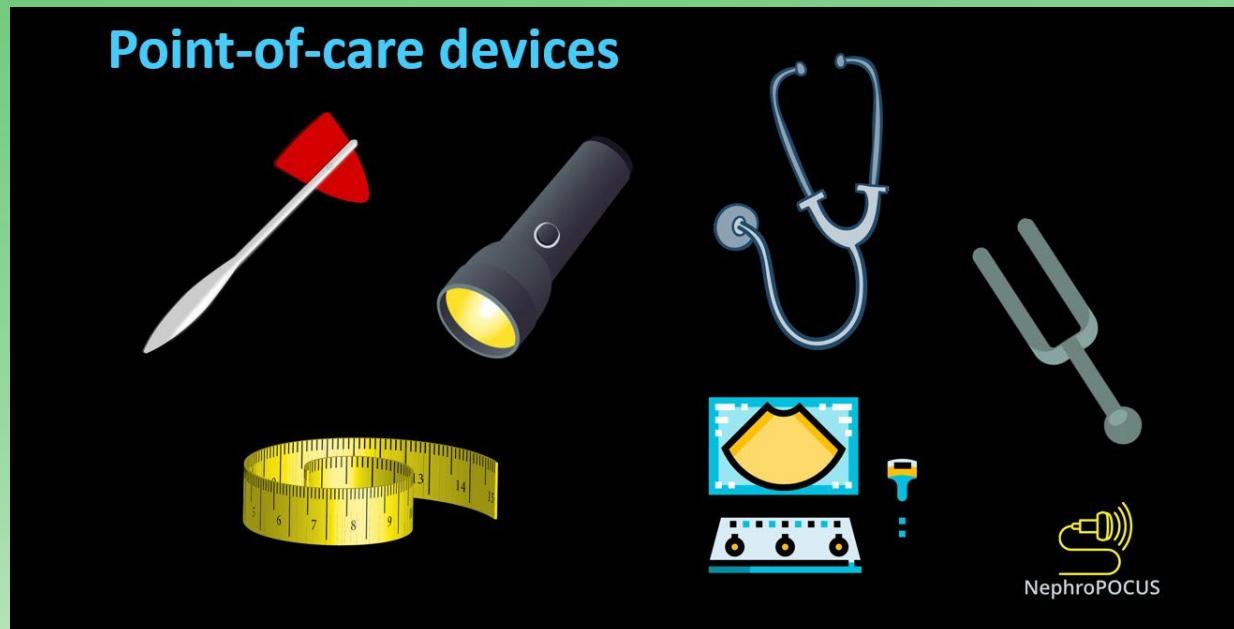
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Definitions

- I. Point-of-care ultrasound (POCUS) is defined as a goal-directed, bedside ultrasound examination performed by a healthcare provider to answer a specific diagnostic question or to guide performance of an invasive procedure.



Comparison

I. Traditional

- A. Comprehensive exam
- B. Sonographer
- C. Interpreted radiologist

I. POCUS

- A. Answers a clinical question
 - i. Fluids, Pressors, Tamponade
 - ii. PE, Pneumothorax, Pulmonary edema
- B. Performed and interpreted at bedside by treating clinician

Applications

I. Procedures

- A. Vascular access
- B. Peripheral nerve blocks
- C. Neuraxial
- D. Thoracentesis, pericardiocentesis, paracentesis, arthrocentesis

Applications

I. Diagnosis

A. Heart

- i. Paracardial effusion/Tamponade
- ii. Left ventricular ejection fraction
- iii. Right ventricular strain
- iv. Aortic or mitral stenosis or regurgitation
- v. Wall motion abnormalities
- vi. Diastolic dysfunction

B. Vasculature

- i. Fluid status
- ii. DVT
- iii. Aneurism

Applications

I. Diagnosis

A. Lung

- i. Pneumothorax
- ii. Pulmonary edema
- iii. Pleural effusion
- iv. Atelectasis
- v. Pneumonia
- vi. Pulmonary embolism

Applications

I. Diagnosis

- A. Gastric
 - i. NPO status

- B. Airway exam
 - i. Vocal cord function
 - ii. Intubation
 - iii. Difficult airway (maybe)

Applications

I. Monitoring

A. Resuscitation

- i. CPR

B. Serialized exams

- i. Pulmonary edema
- ii. Fluid resuscitation
- iii. Response to inotropes

Physics

I. Piezoelectric crystals

- A. Electricity applied to the crystals cause vibration creating ultrasound waves
- B. Ultrasound waves returning to the crystals cause vibration creating an electrical signal
- C. 1% sending, 99% listening

Physics

I. Frequency

- A. Human hearing 20-20,000Hz
- B. Ultrasound 1-15 MHz (1,000,000-15,000,000)
- C. Higher frequency = better resolution
- D. Lower frequency = better penetration

Physics

I. Wave propagation

A. Reflection

- i. Maximized when beam and object is perpendicular

B. Attenuation

- i. Signal is lost
- ii. Refraction, scatter, and absorption

C. Hyperechoic, hypoechoic, and anechoic

Probeology

I. Types

A. Linear

- i. 8-13 MHz

B. Curvilinear

- i. 2-5 MHz
- ii. Wider field of view

C. Phased Array “cardiac”

- i. 1-5 MHz

Probeology

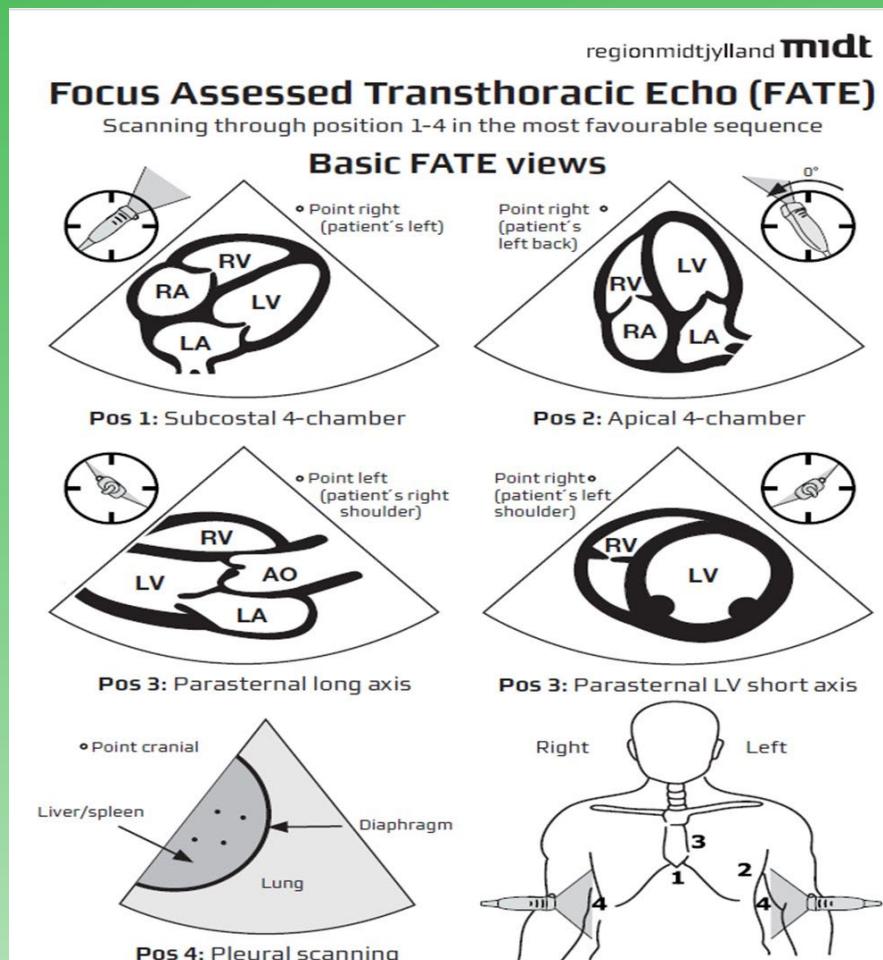


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Fate



Focus Assessed Transthoracic Echo (FATE)

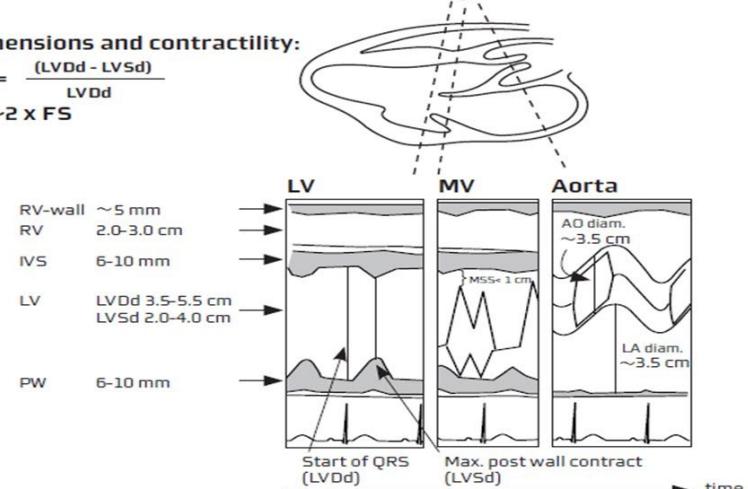
(European Journal of Anaesthesiology 2004; 21: 700-707)

1. Look for obvious pathology
2. Assess wall thickness + chamber dimensions
3. Assess bi - ventricular function
4. Image pleura on both sides
5. Relate the information to the clinical context
6. Apply additional ultrasound

Dimensions and contractility:

$$FS = \frac{(LVDd - LVsd)}{LVDd}$$

$$EF \sim 2 \times FS$$



The global function of the heart is determined by the interaction between:

Right ventricle	Left Ventricle
Systole: Preload Afterload Contractility Heart rate	Diasystole: Compliance Relaxation Heart rate

Hemodynamic instability, perform a systematic evaluation of these determinants plus concomitant pathology:
(e.g. pericardial effusion, pulmonary embolus, pleural effusion, pneumothorax, valvulopathy, dissection, defects)

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Important pathology

PATHEOLOGY TO BE CONSIDERED IN PARTICULAR:

- Post OP cardiac surgery, following cardiac catheterisation, trauma, renal failure, infection.
- ▲ Pulmonary embolus, RV infarction, pulmonary hypertension, volume overload.
- Ischemic heart disease, dilated cardiomyopathy, sepsis, volume overload, aorta insufficiency.
- Aorta stenosis, arterial hypertension, LV outflow tract obstruction, hypertrophic cardiomyopathy, myocardial deposit diseases.

Extended FATE views

Pos 1: Subcostal Vena Cava
Point cranial (patient's left shoulder)

Pos 2: Apical 2 - Chamber
Point right (patient's left shoulder)

Pos 2: Apical Long - axis
Point left (patient's right shoulder)

Pos 3: Parasternal short axis mitral plane
Point right (patient's back)

Pos 3: Parasternal aorta short axis
Point right (patient's left shoulder)

CW: Peak pressure: $V^2 \times 4$; AO < 2 m/s; PA < 1 m/s; TI < 2.5 m/s
PW: Mitral inflow desc. time 140 - 240 ms; MAX E < 1.2 m/s; E/A > 1 (Age dependent)
TVI: E/e < 8-10; IVC < 20 mm; 50% collaps during inspiration is normal

Systolic Ventricular Function

Ventricle	M-Mode	Normal	Mild ↓	Moderately ↓	Severely ↓
LV	Pos 3, PS long EF (%)	≥ 55	45 - 54	30 - 44	< 30
LV	Pos 3, PS long FS (%)	≥ 25	20 - 24	15 - 19	< 15
LV	Pos 3, PS long MSS (mm)	< 10	7 - 12	13 - 24	> 24
LV	Pos 2, AP 4ch Mapse (mm)	≥ 11	9 - 10	6 - 8	< 6
RV	Pos 2, AP 4ch Tapse (mm)	16 - 20	11 - 15	6 - 10	< 6

Right and left ventricle Eye Balling use all views

Disclaimer: The authors do not assume any responsibility for the use of this FATE Card. Layout: Department of Communication, Aarhus University Hospital Skejby - ES410LB

For additional information: www.usabcd.org

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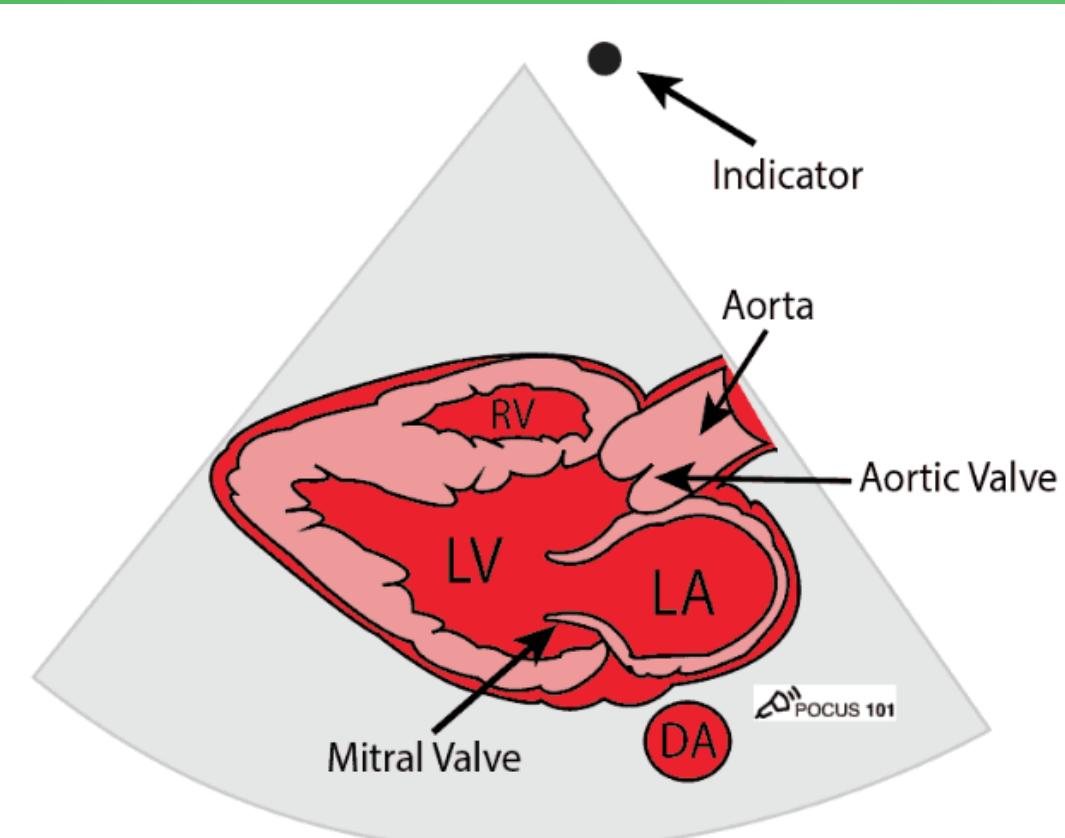


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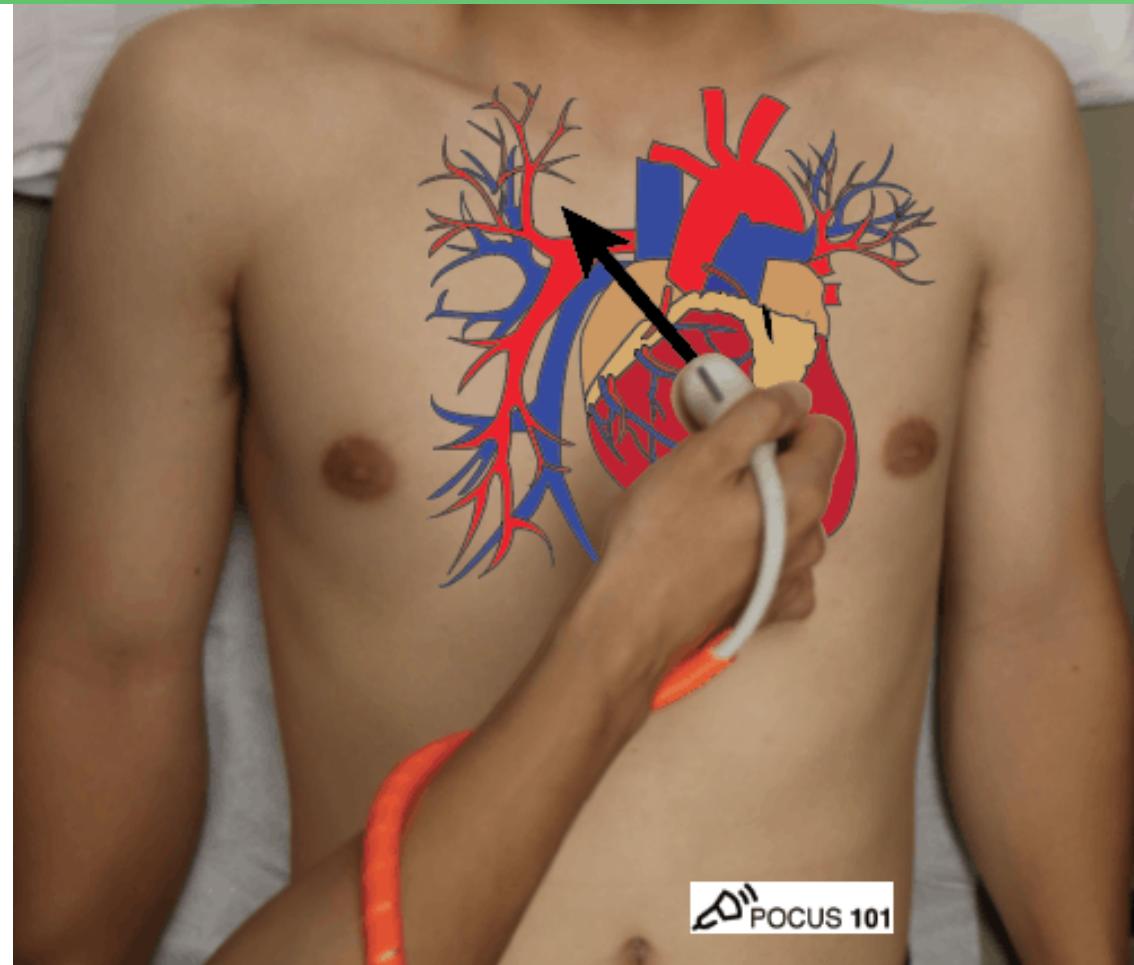
Parasternal Long Axis View

- I. Ejection fraction
- II. Chamber size
- III. Pericardial effusion
- IV. Mitral and Aortic valves

Parasternal LAX



Parasternal Long Axis View Structures – Illustration

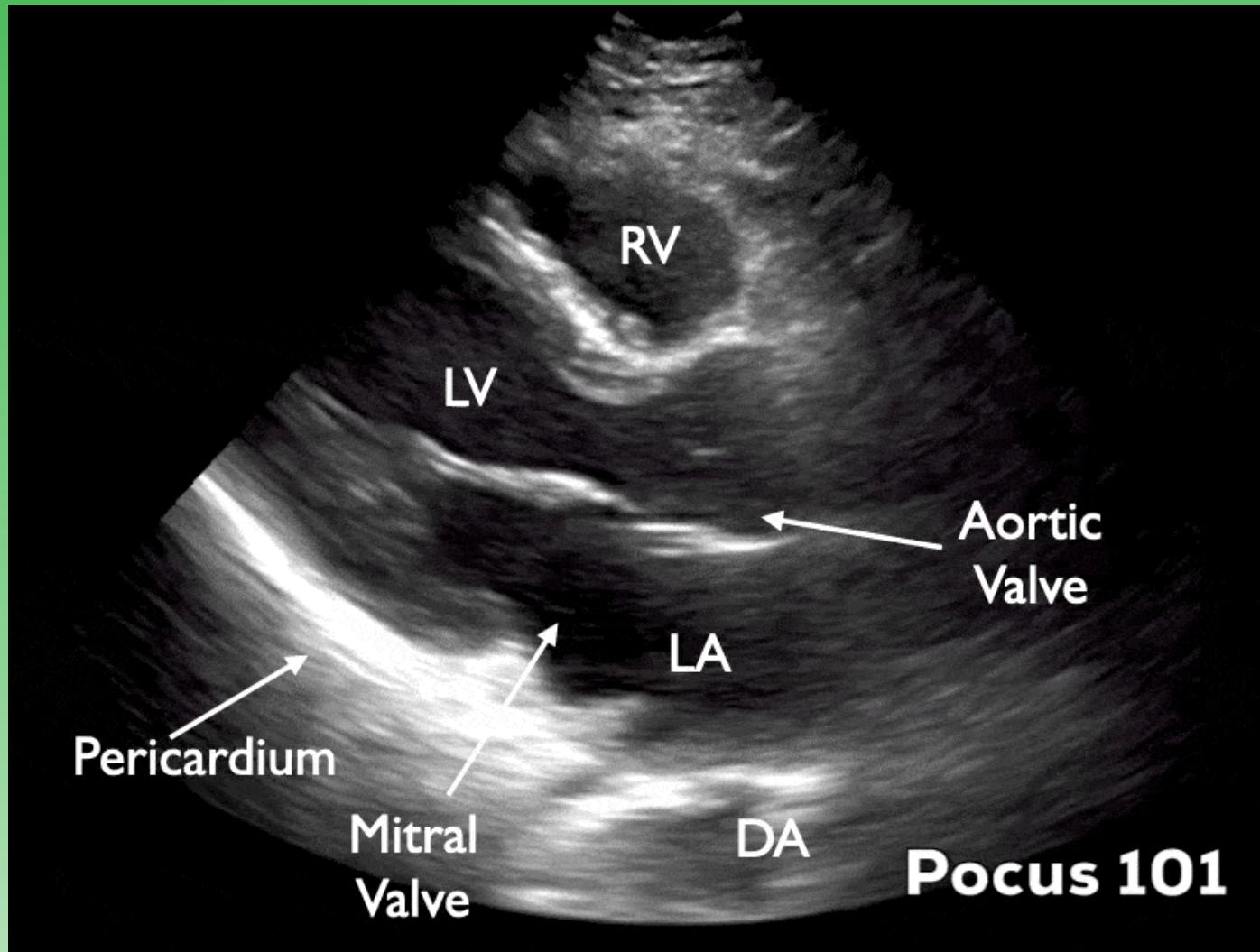


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PLAX



Parasternal Short Axis View

I. Papillary Muscles

- A. Ejection fraction
- B. Chamber sizes
- C. Wall motion abnormalities
- D. Pericardial effusion

II. Mitral Valve

- A. Mitral valve assessment

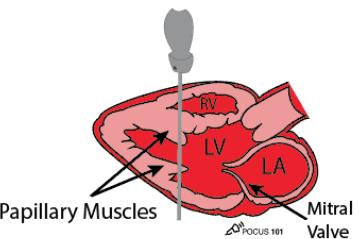
III. Aortic Valve

- A. Aortic and Tricuspid valve assessment

Parasternal SAX

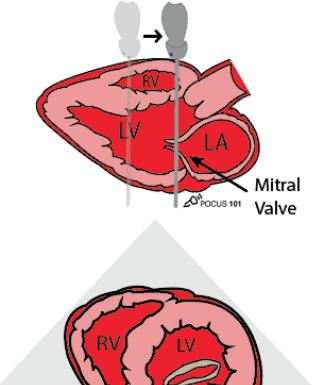
PARASTERNAL SHORT AXIS VIEWS

POCUS 101



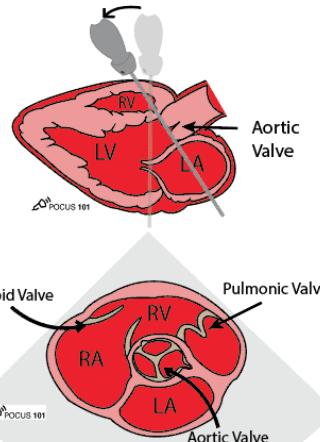
Mid-Papillary Level

Slide the Probe Towards the Mitral Valve

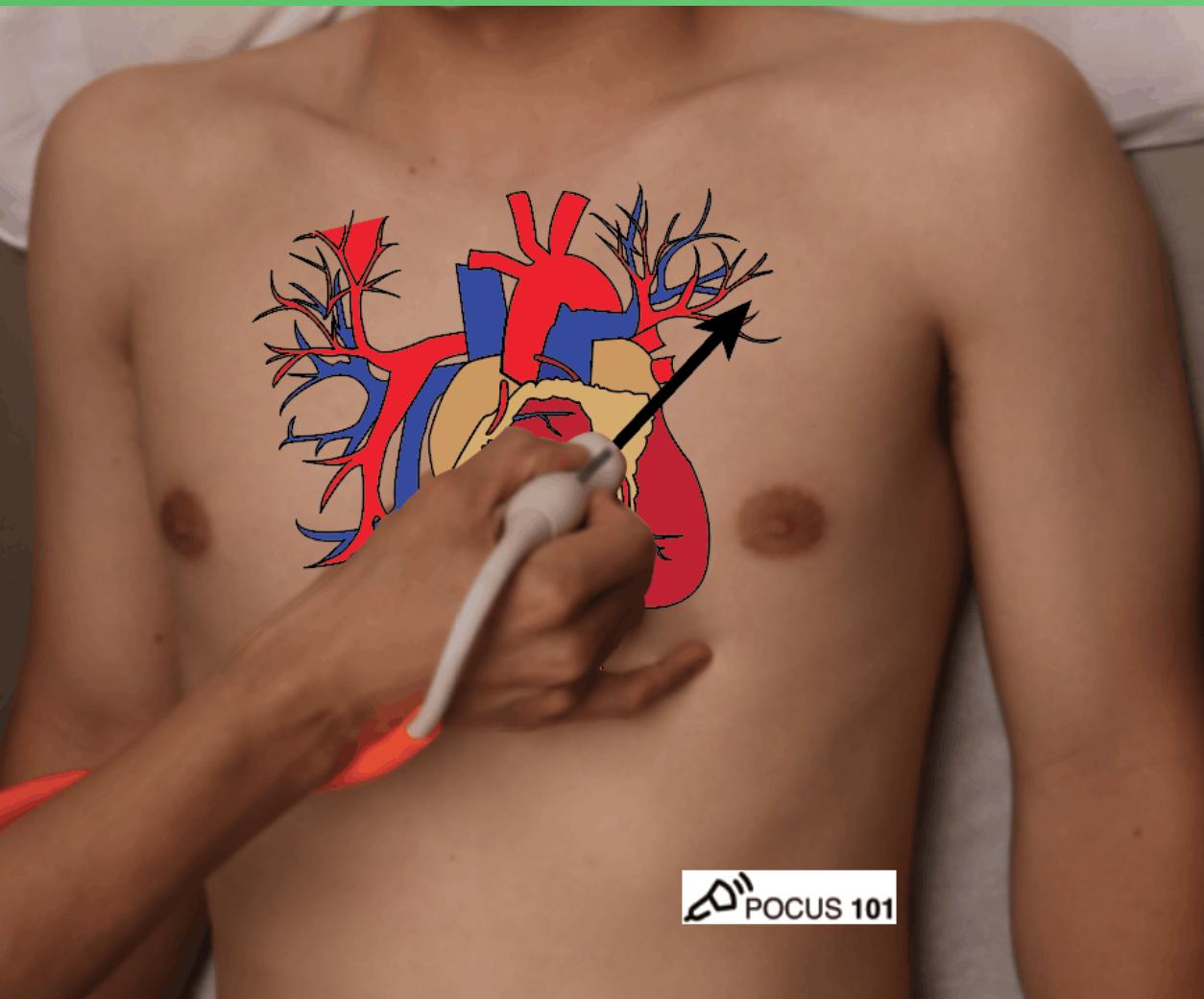


Mitral Valve Level
("Fish Mouth" View)

Tilt the Probe Towards the Base of the Heart



Aortic Valve Level
("Mercedes Benz" View)



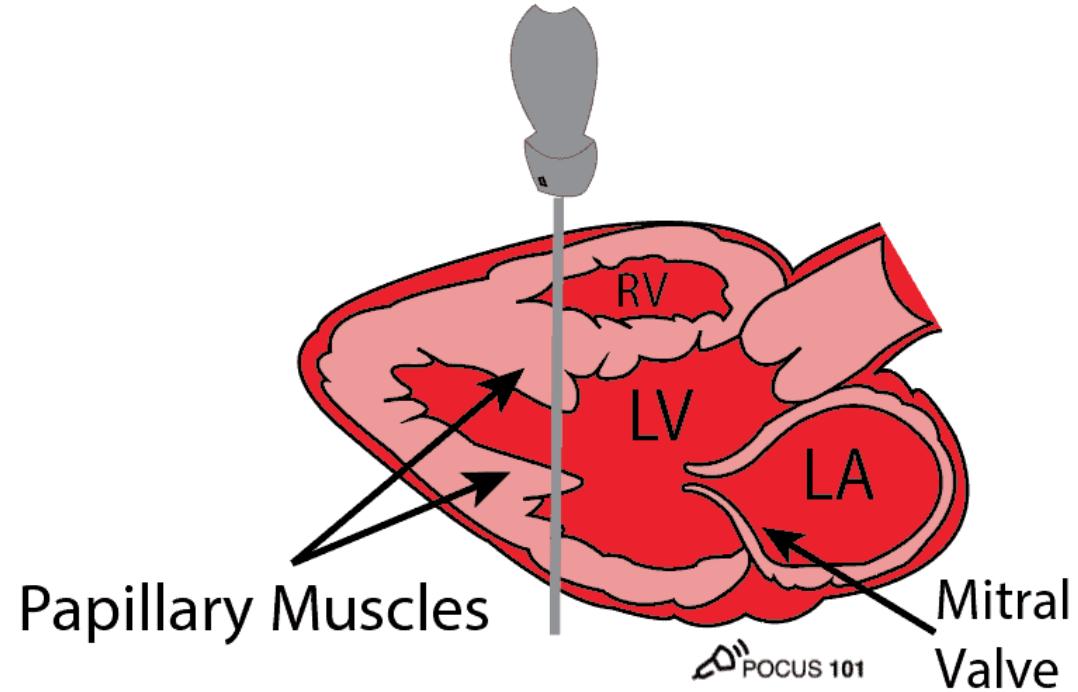
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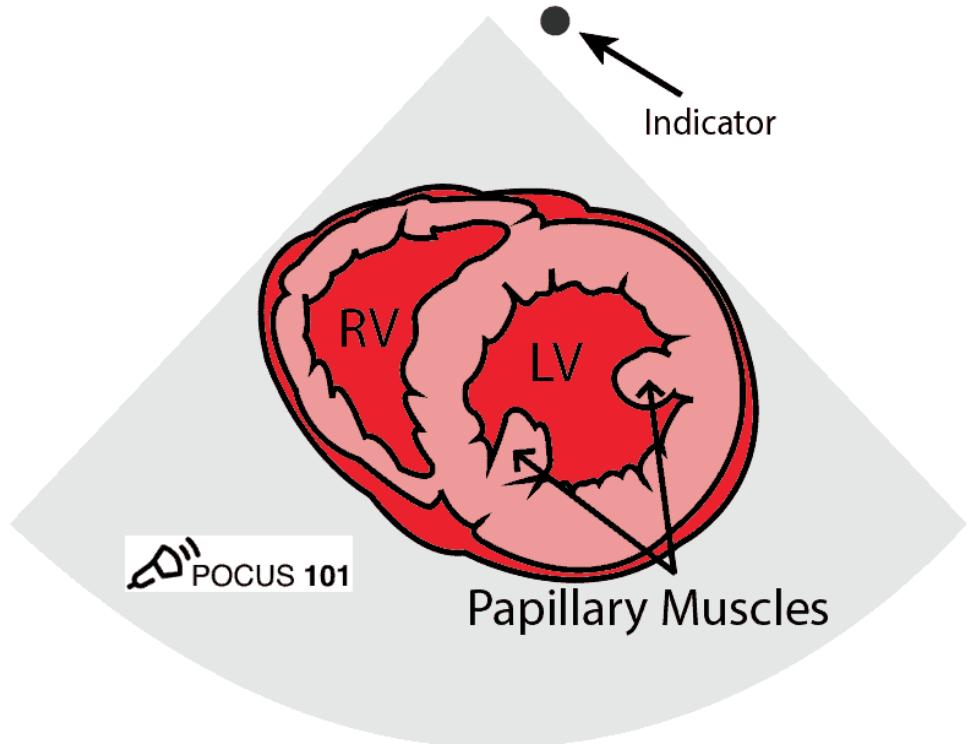


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PSAX Papillary

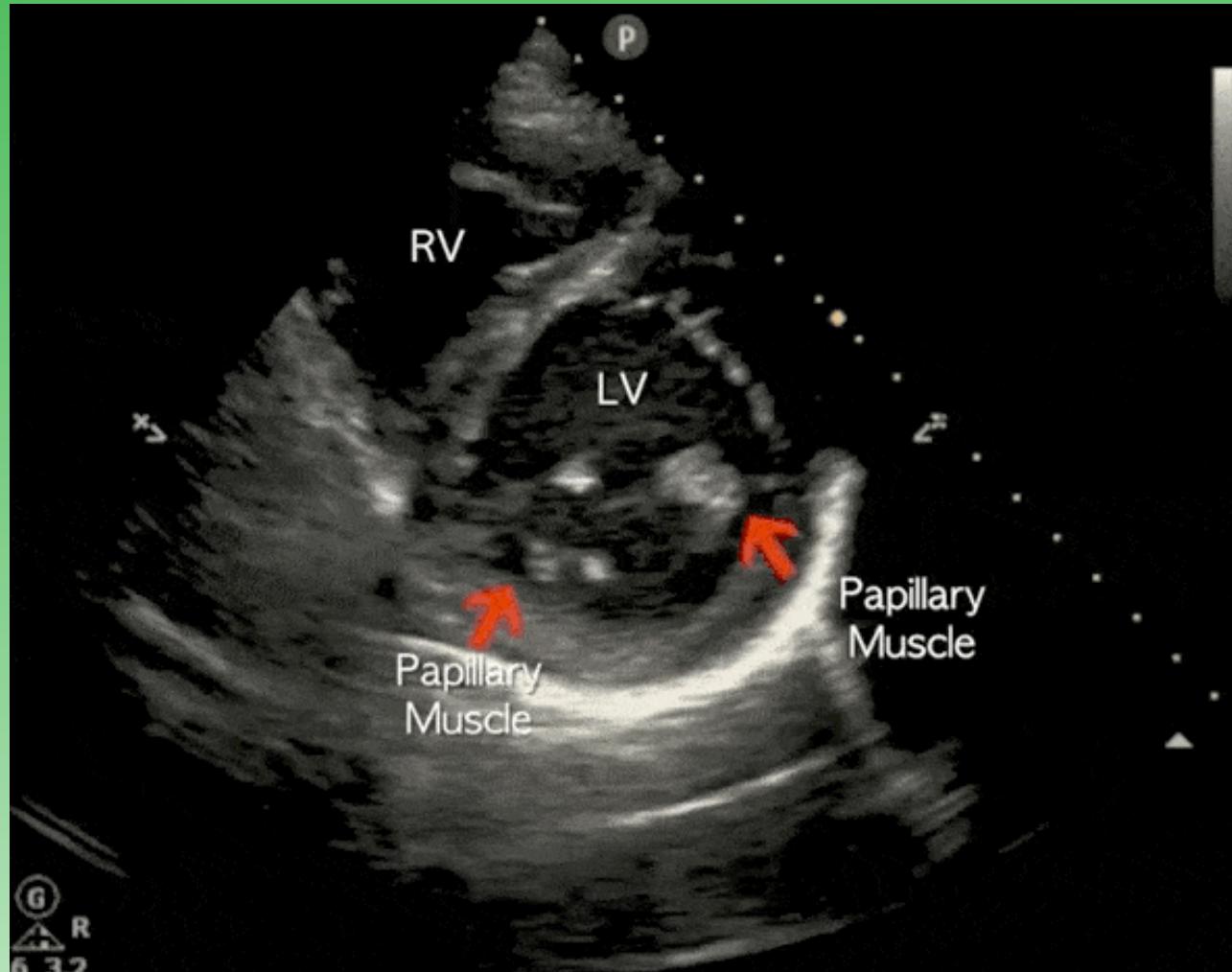


Mid-Papillary Level



Mid-Papillary Level

PSAX Papillary



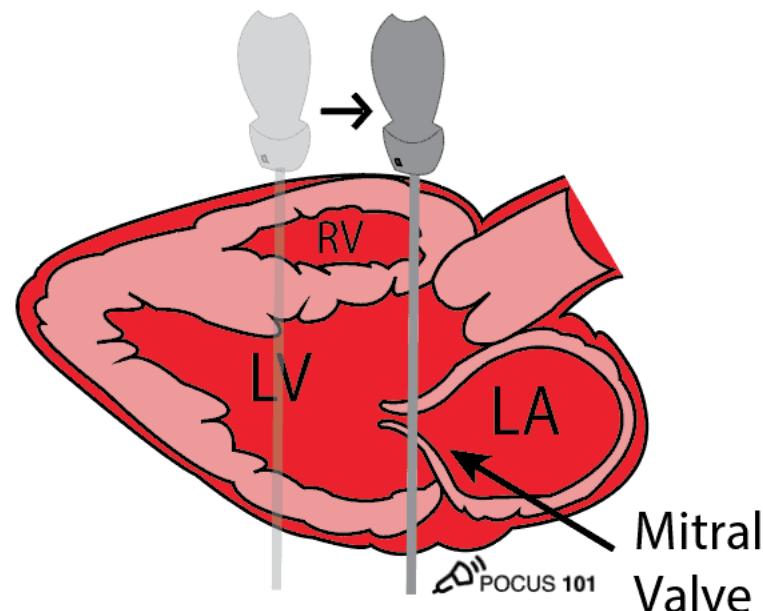
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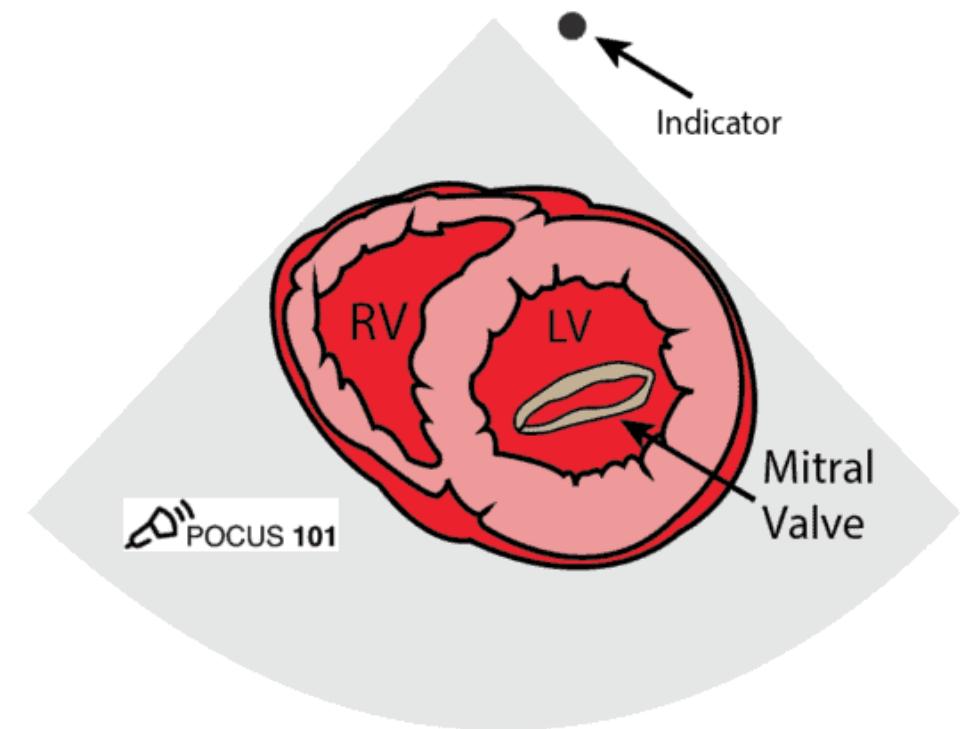
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PSAX Mitral Valve

Slide the Probe Towards
the Mitral Valve



Mitral Valve Level



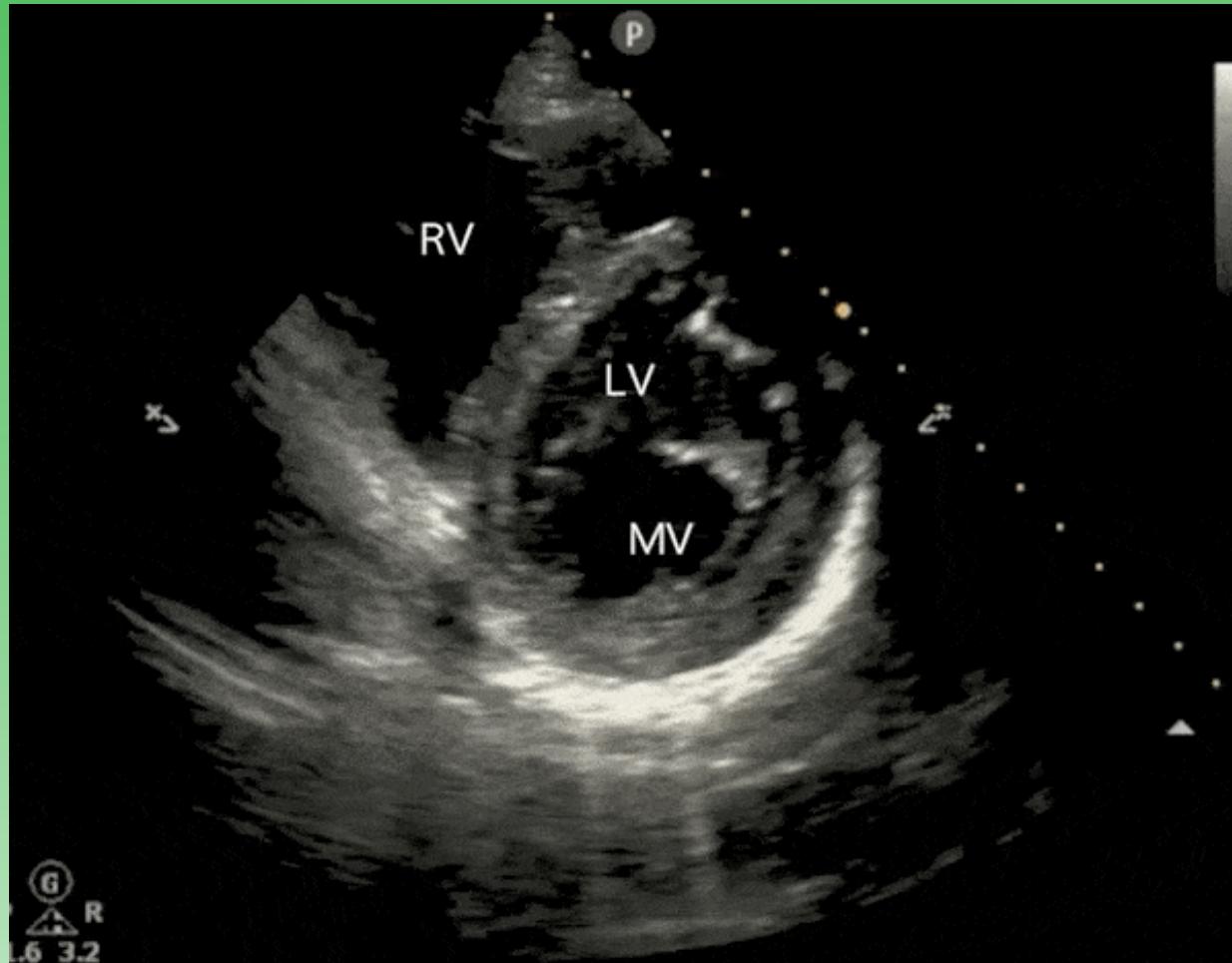
**Mitral Valve Level
("Fish Mouth" View)**

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PSAX Mitral valve



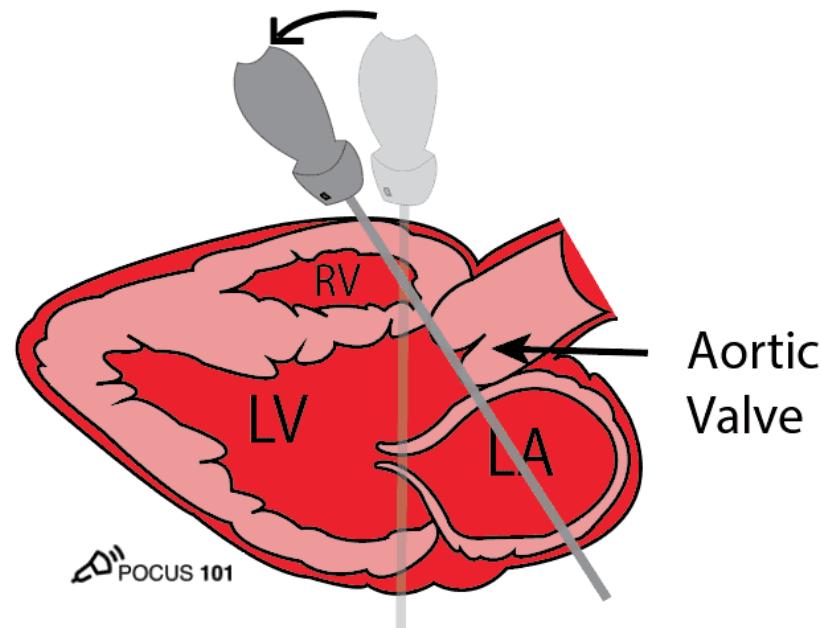
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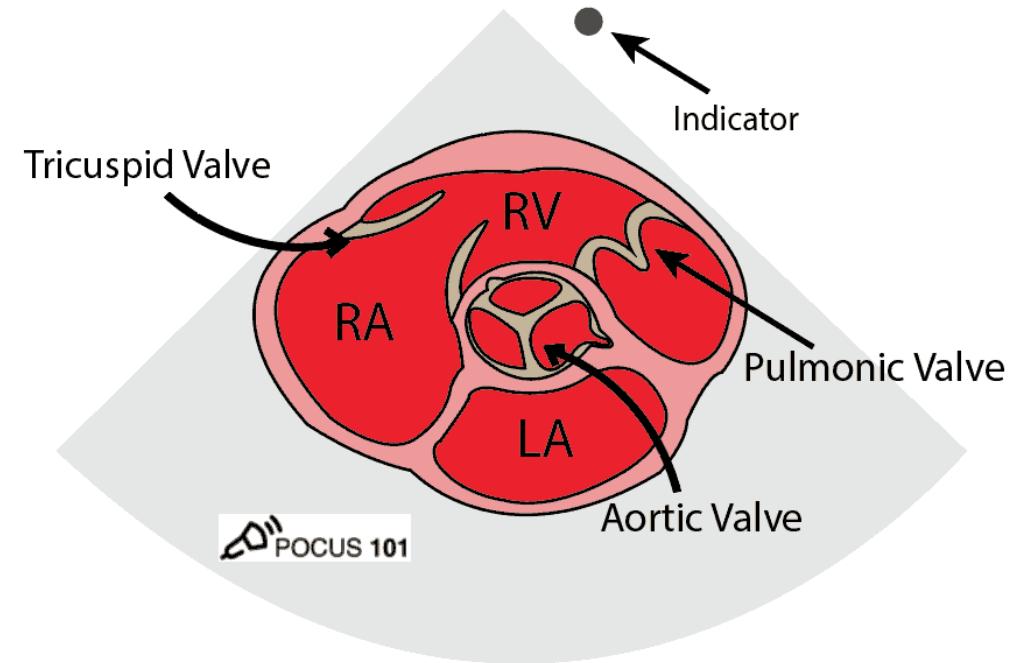
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PSAX Aortic valve

Tilt the Probe Towards
the Base of the Heart

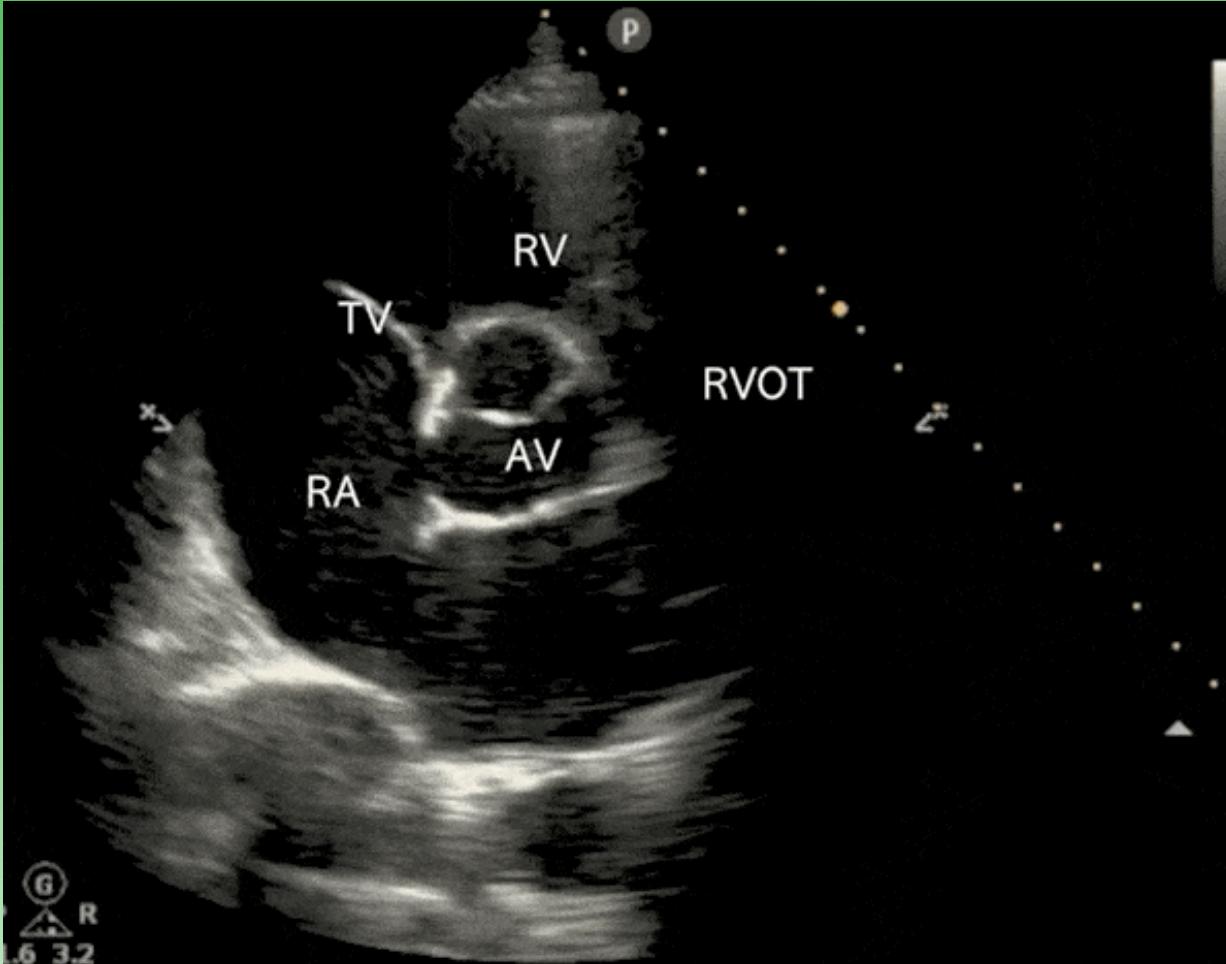


Aortic Valve Level



**Aortic Valve Level
("Mercedes Benz" View)**

PSAX Aortic Valve



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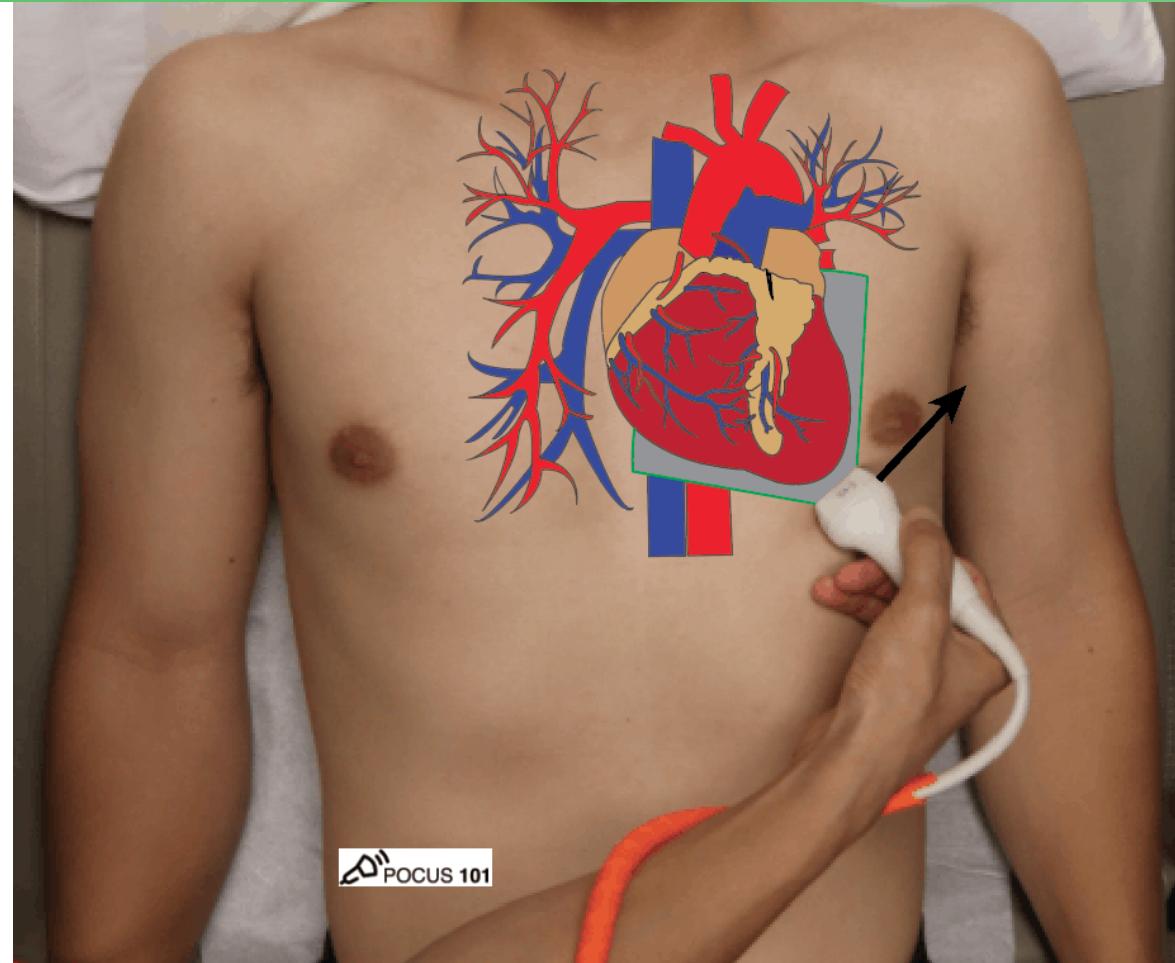
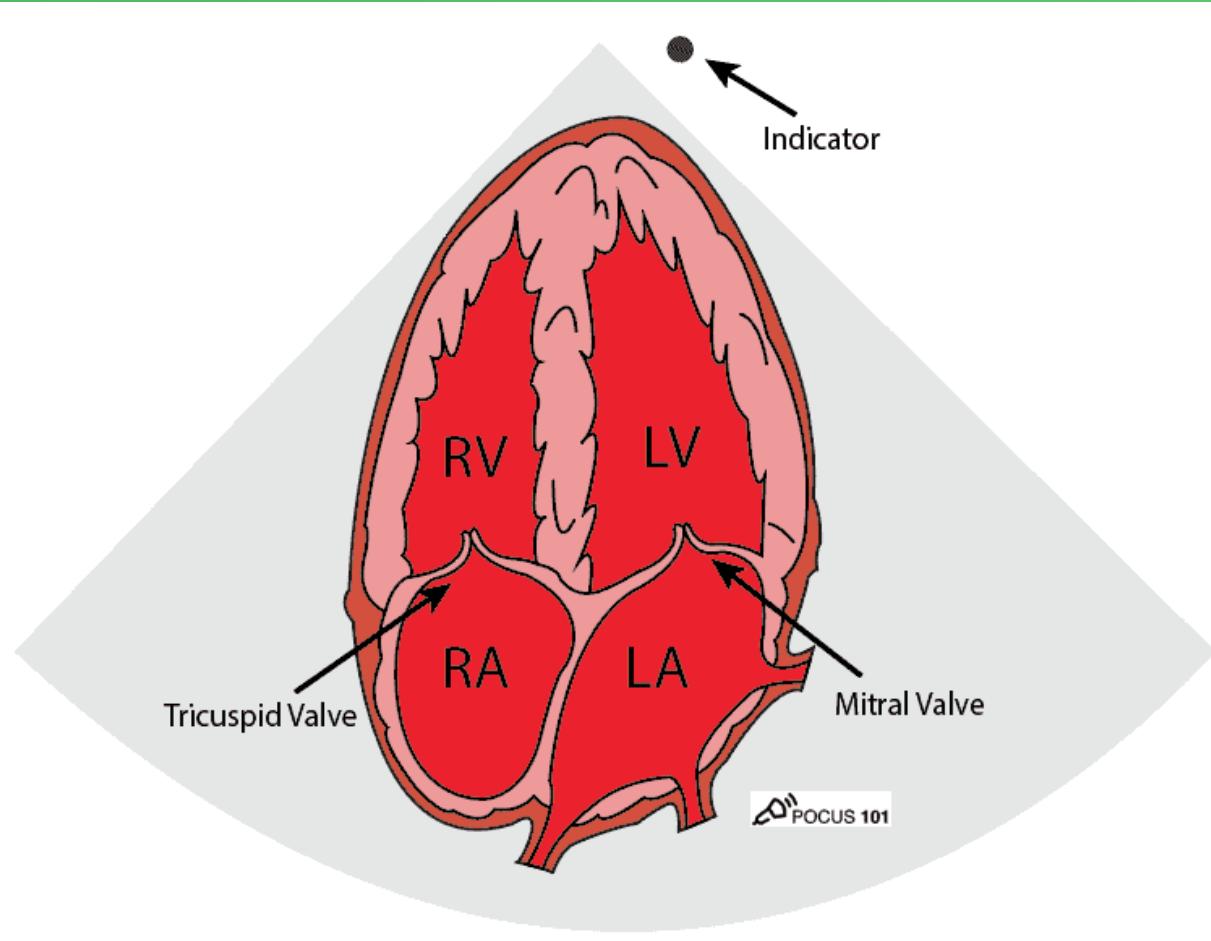


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Apical 4 Chamber

- I. Ejection Fraction
- II. Chamber size
- III. Pericardial effusion
- IV. Mitral and tricuspid valve assessment
- V. Hemodynamic calculations
- VI. Diastolic dysfunction

Apical 4 Chamber

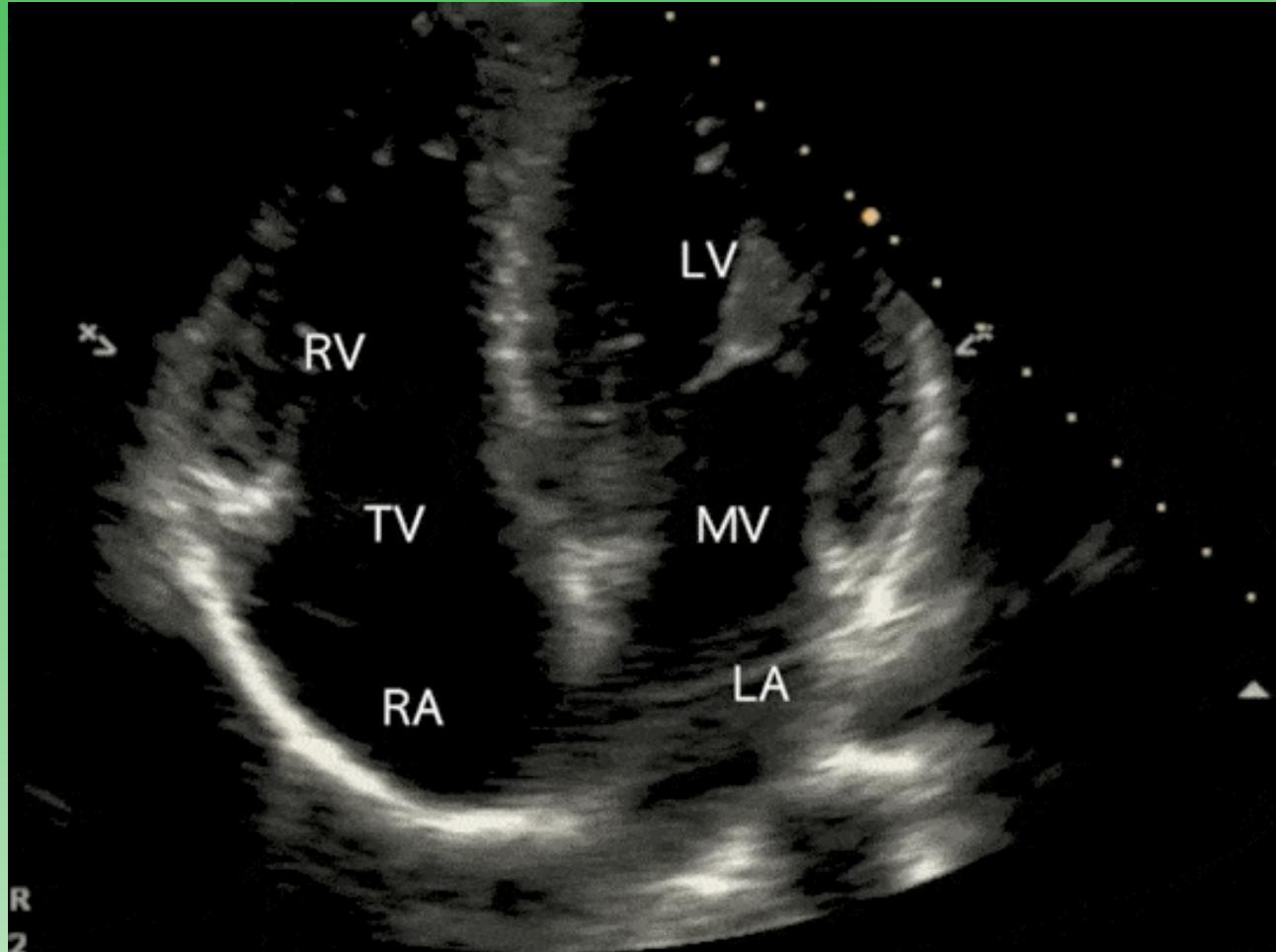


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A4C



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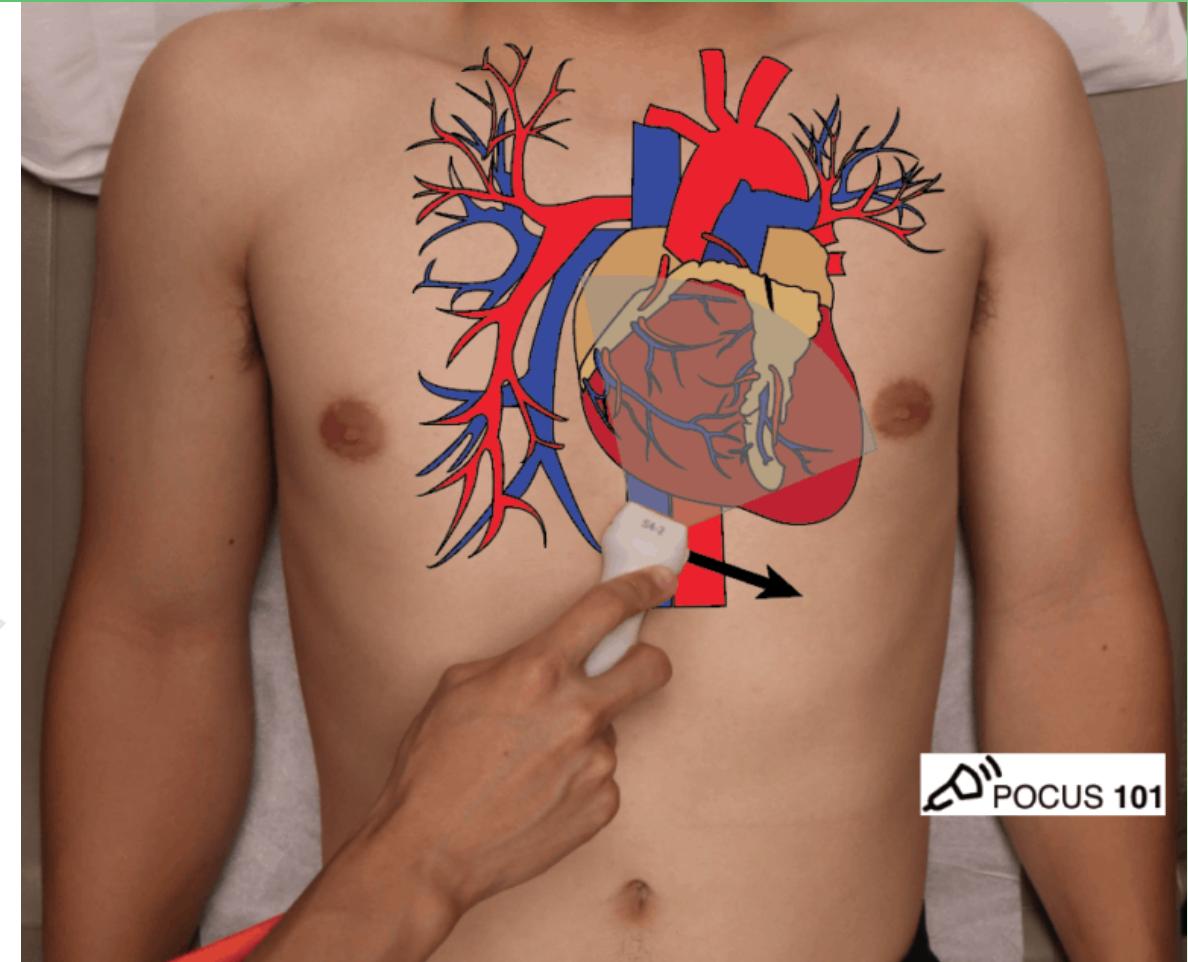
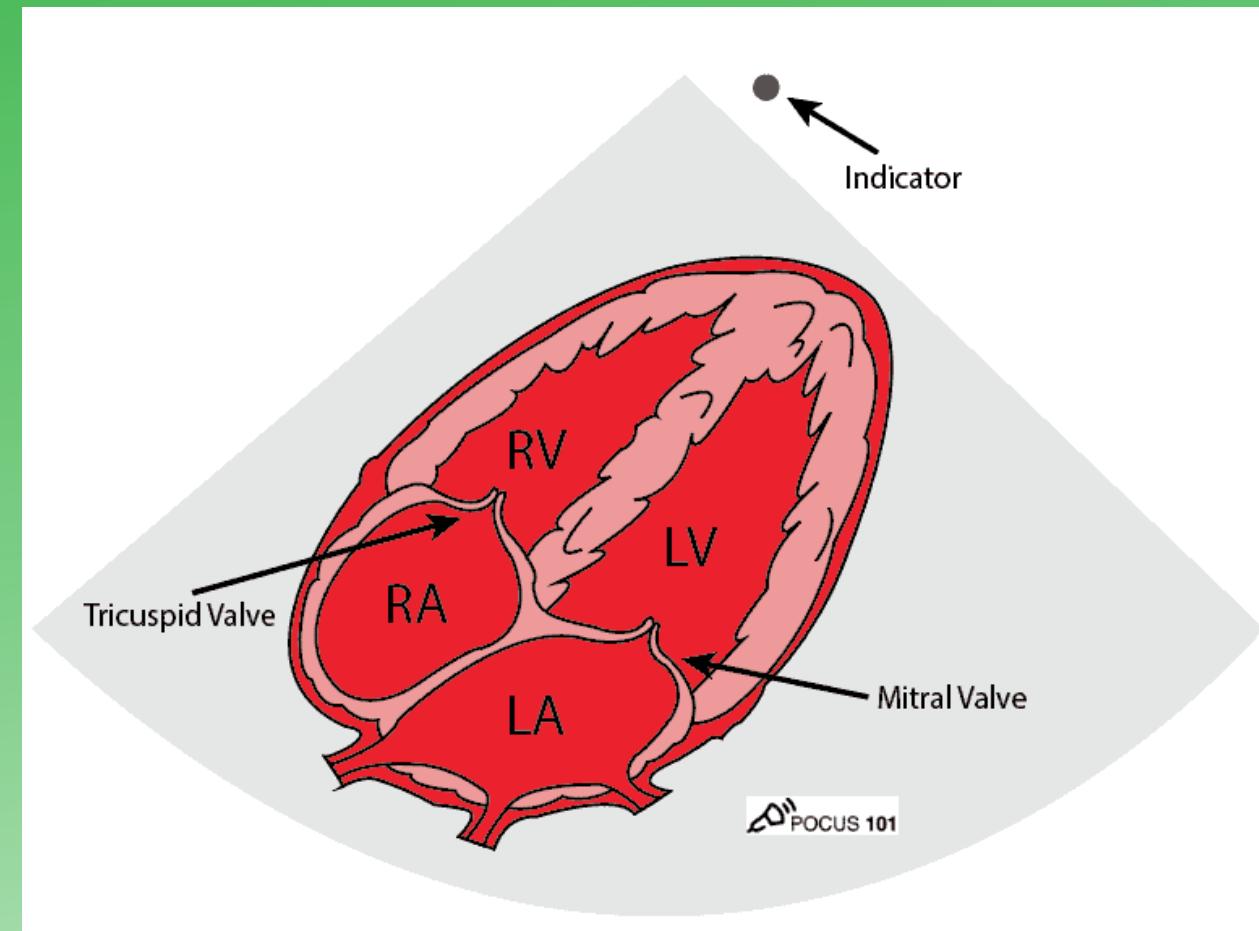


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Subxiphoid

- I. Useful when A4C is difficult to obtain
- II. Useful during CPR as probe placement is out of the way

Subxiphoid

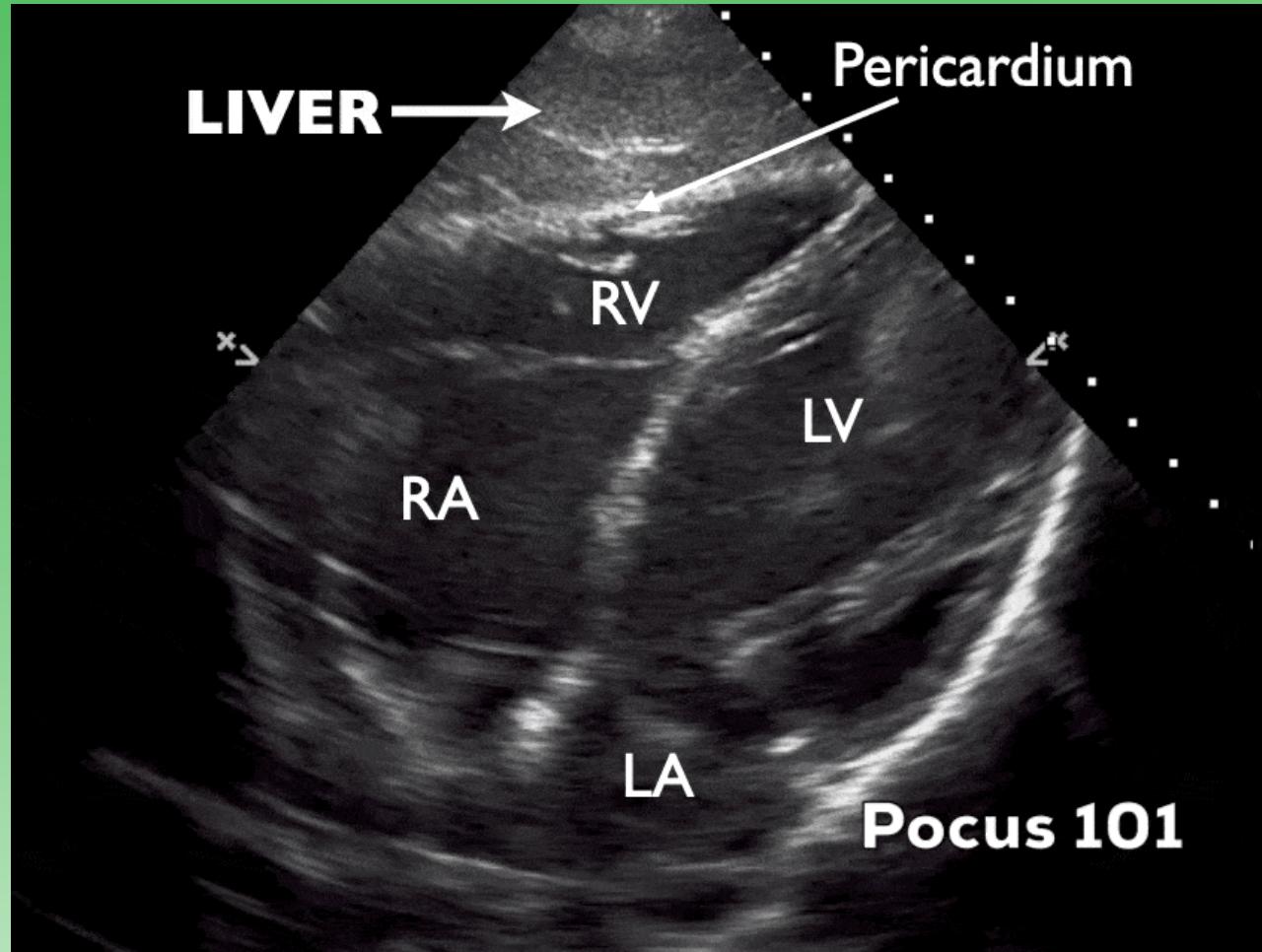


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Subxiphoid



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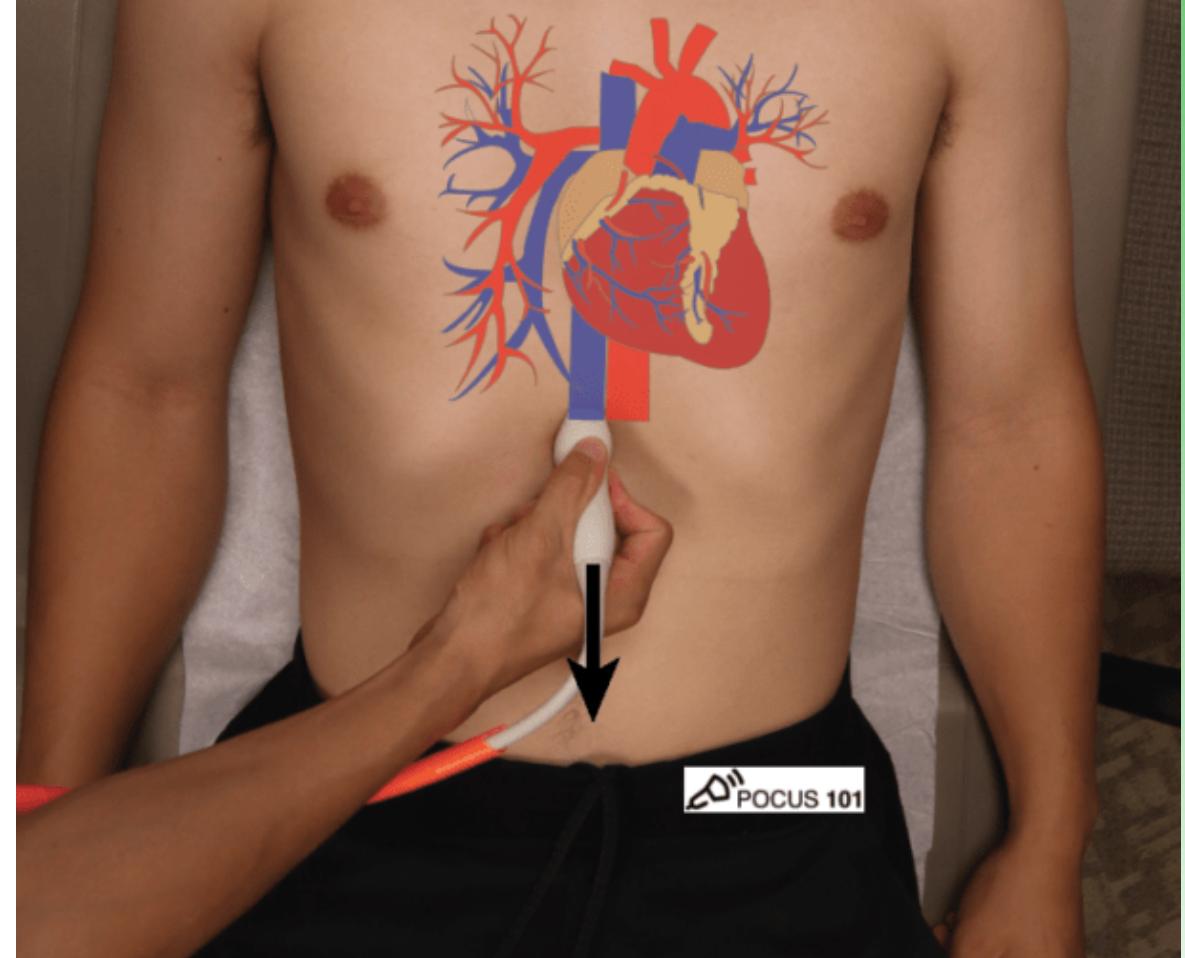
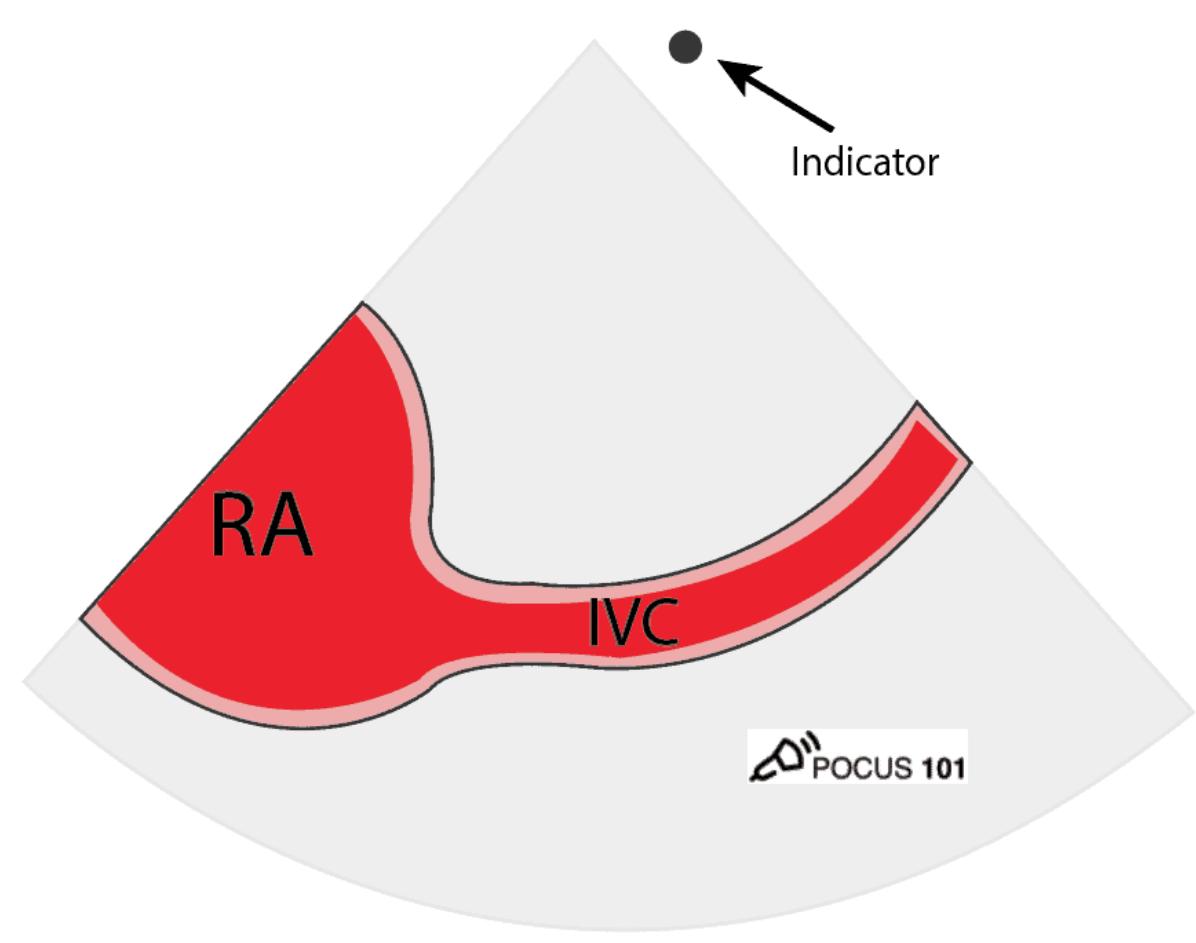


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IVC

I. Fluid volume status

IVC

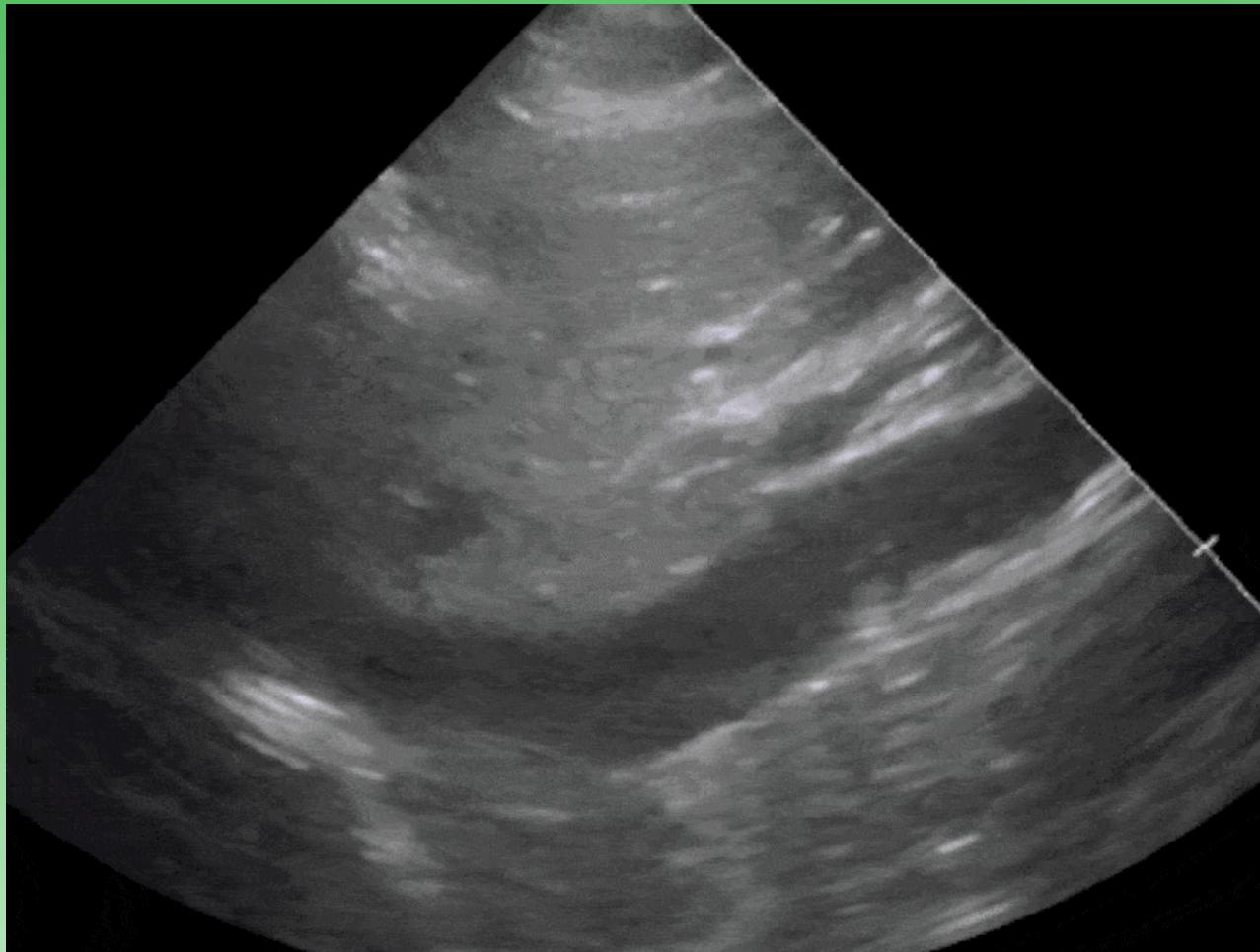


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Subxiphoid

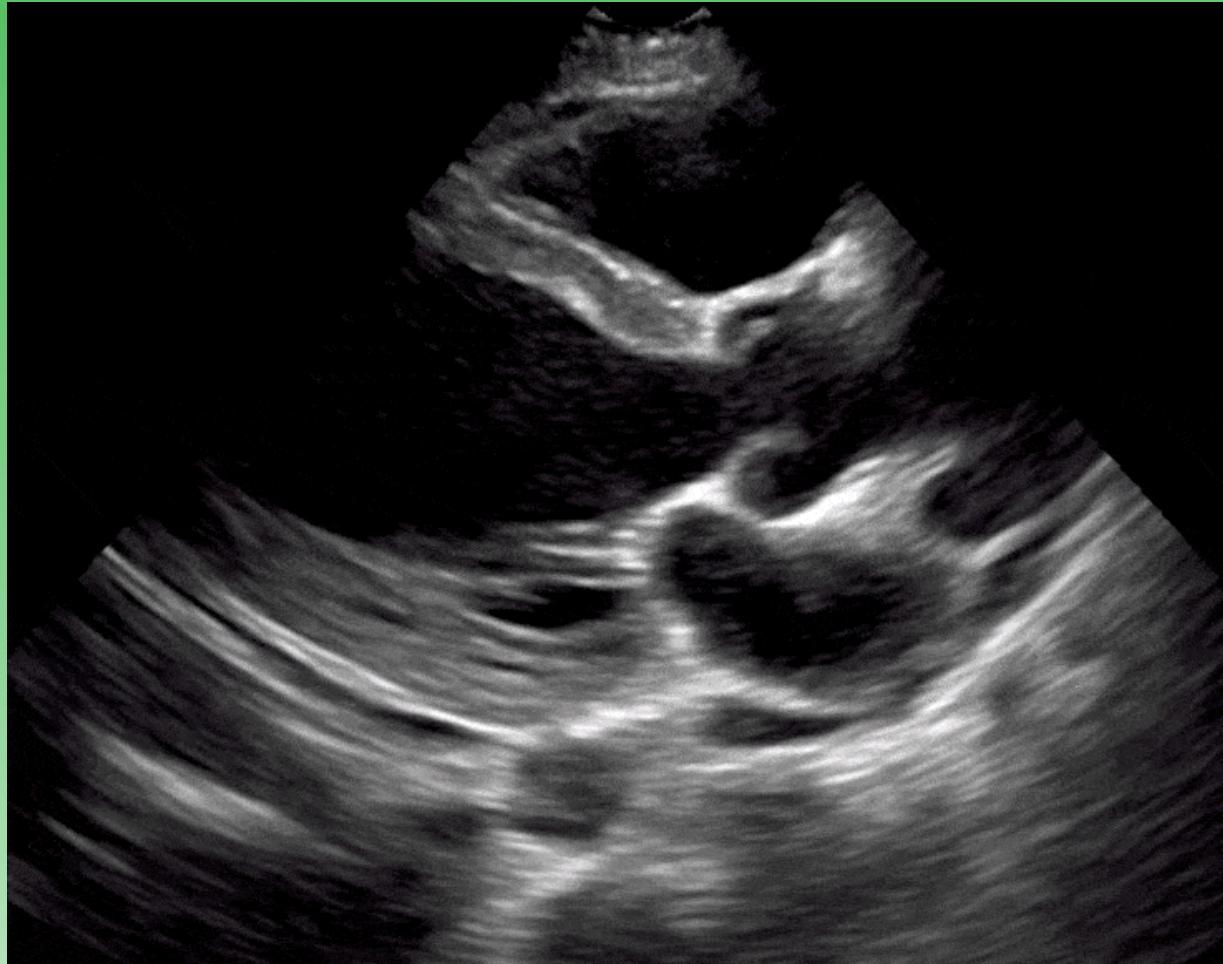


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Pathology Ejection Fraction

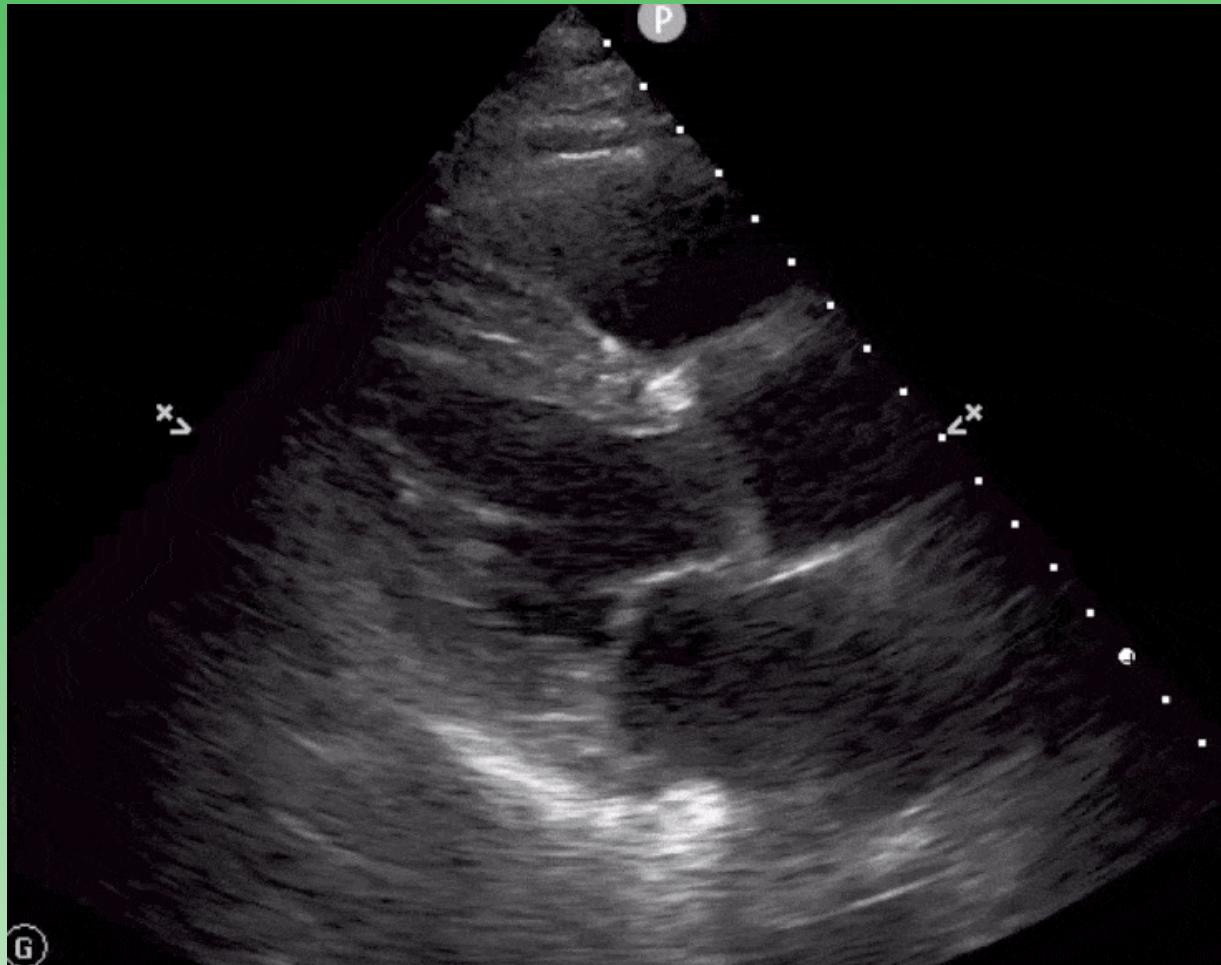


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Pathology Ejection Fraction



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Pathology Ejection Fraction

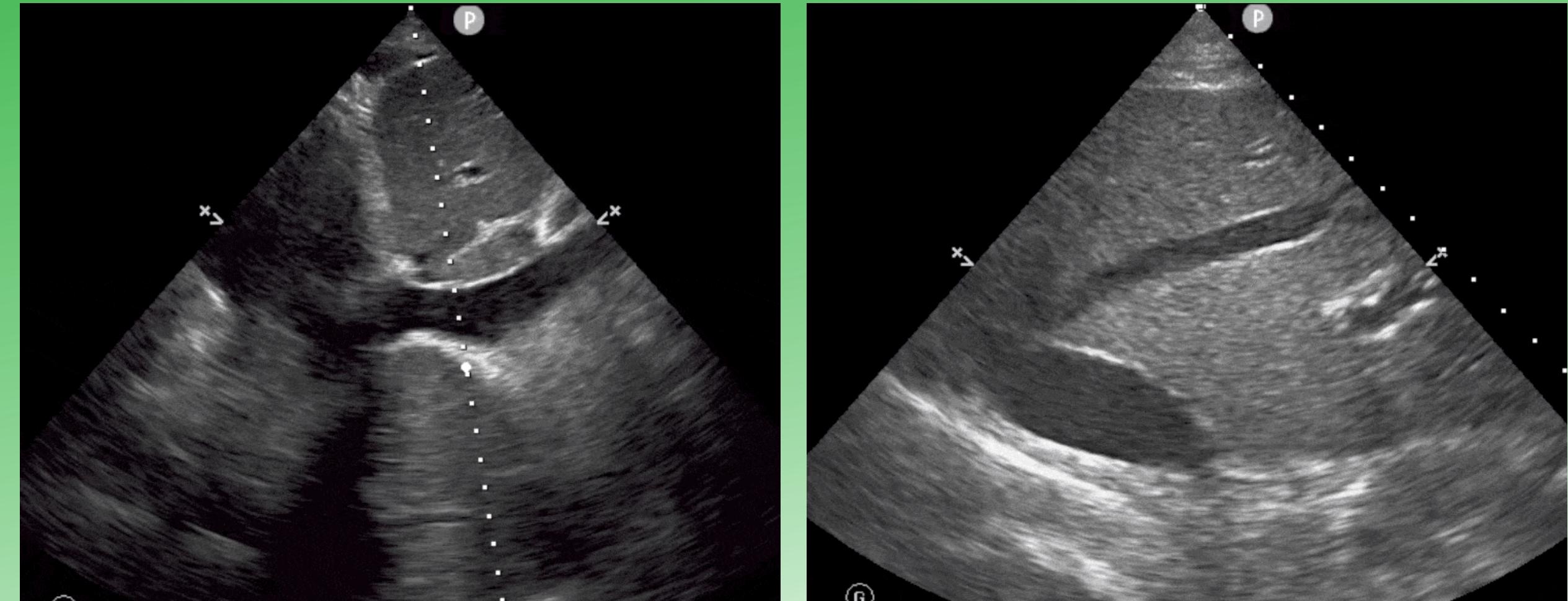


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Pathology IVC

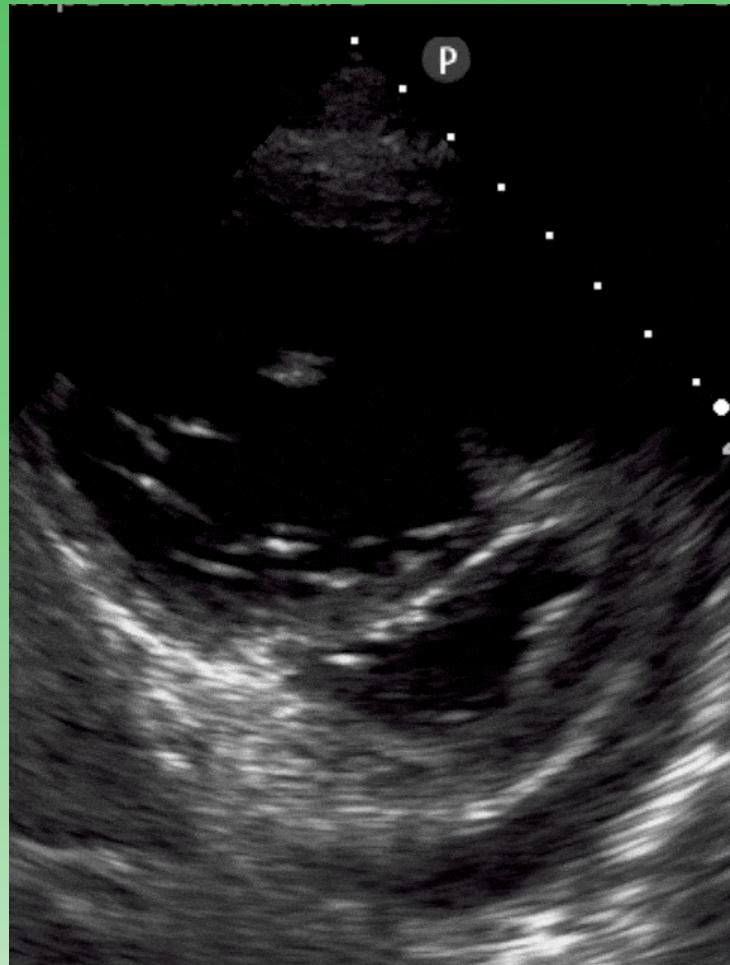


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Pathology PE

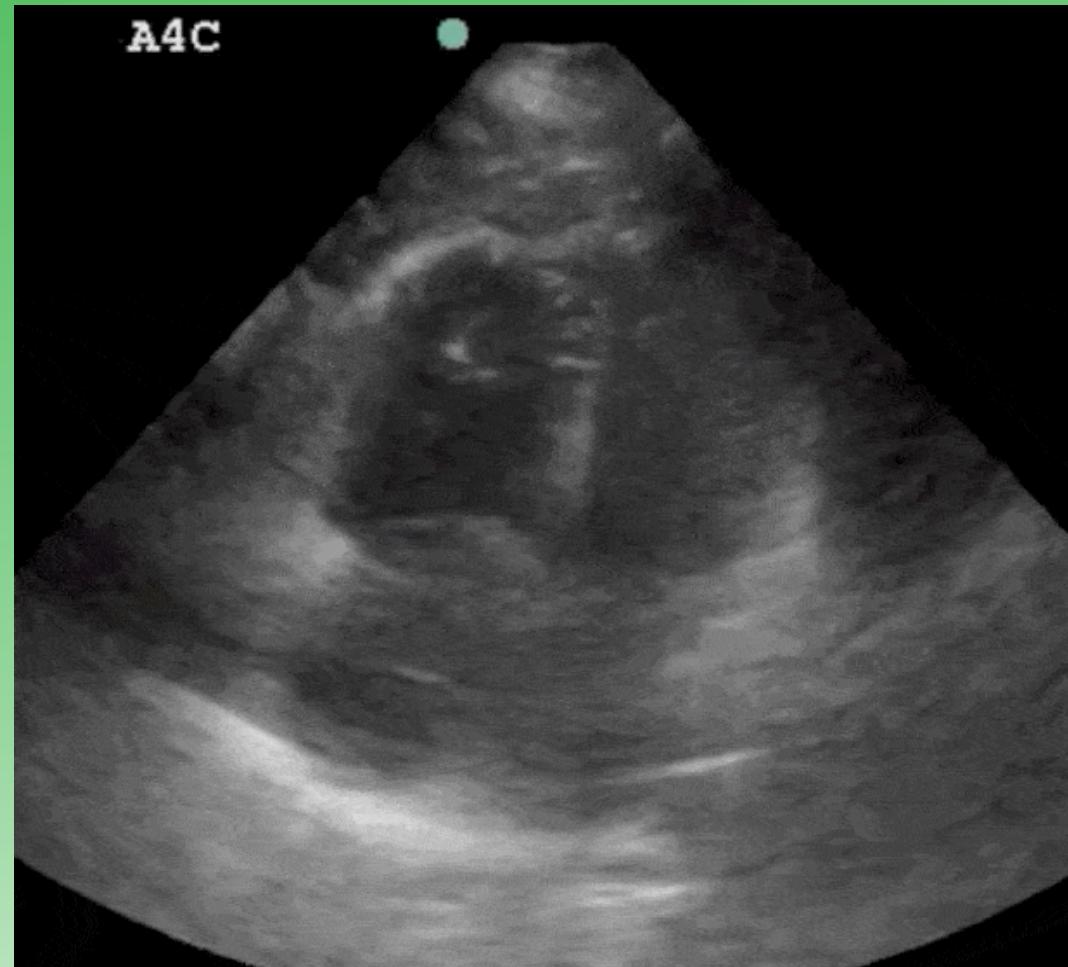


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Pathology PE

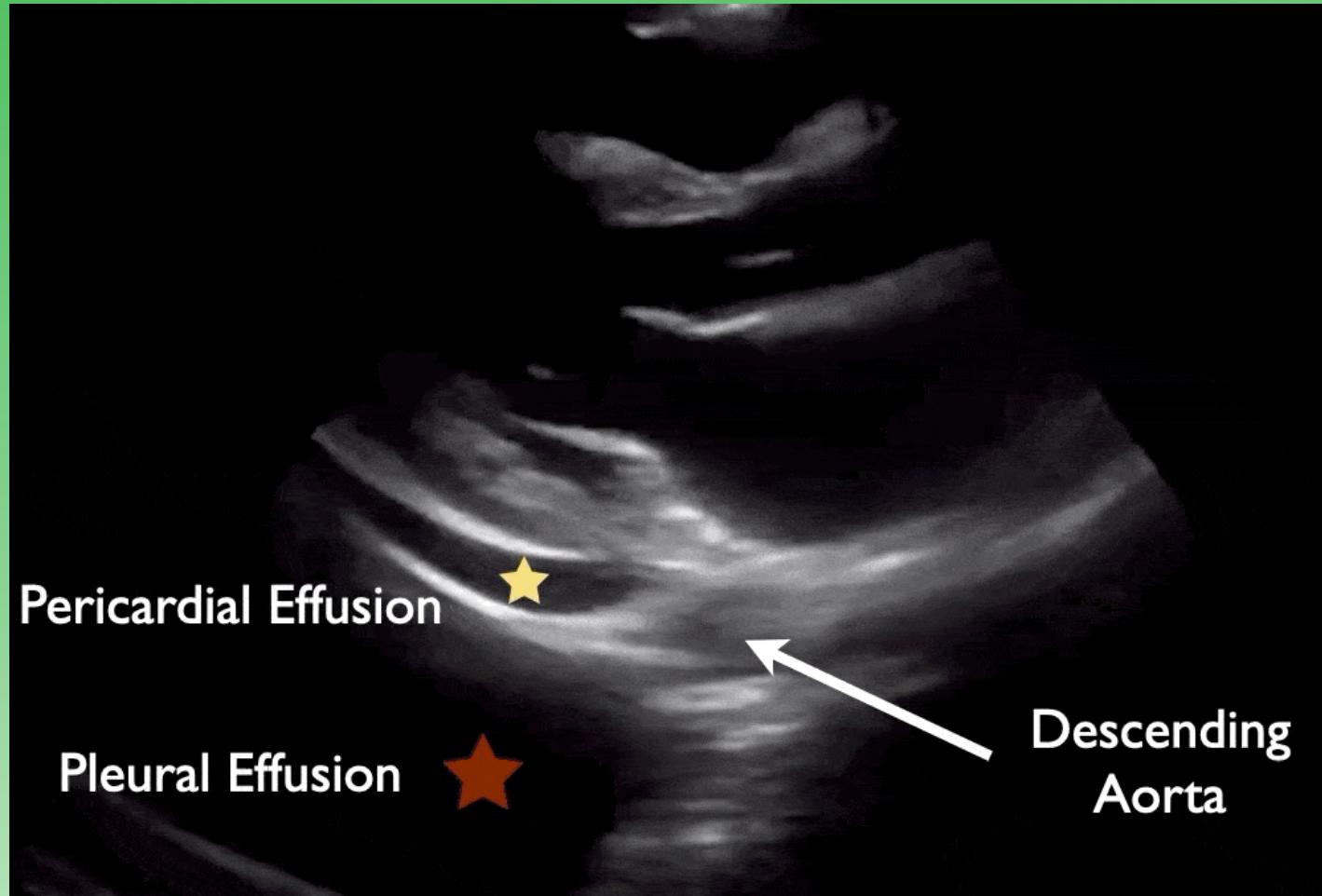


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Pathology Pericardial Effusion

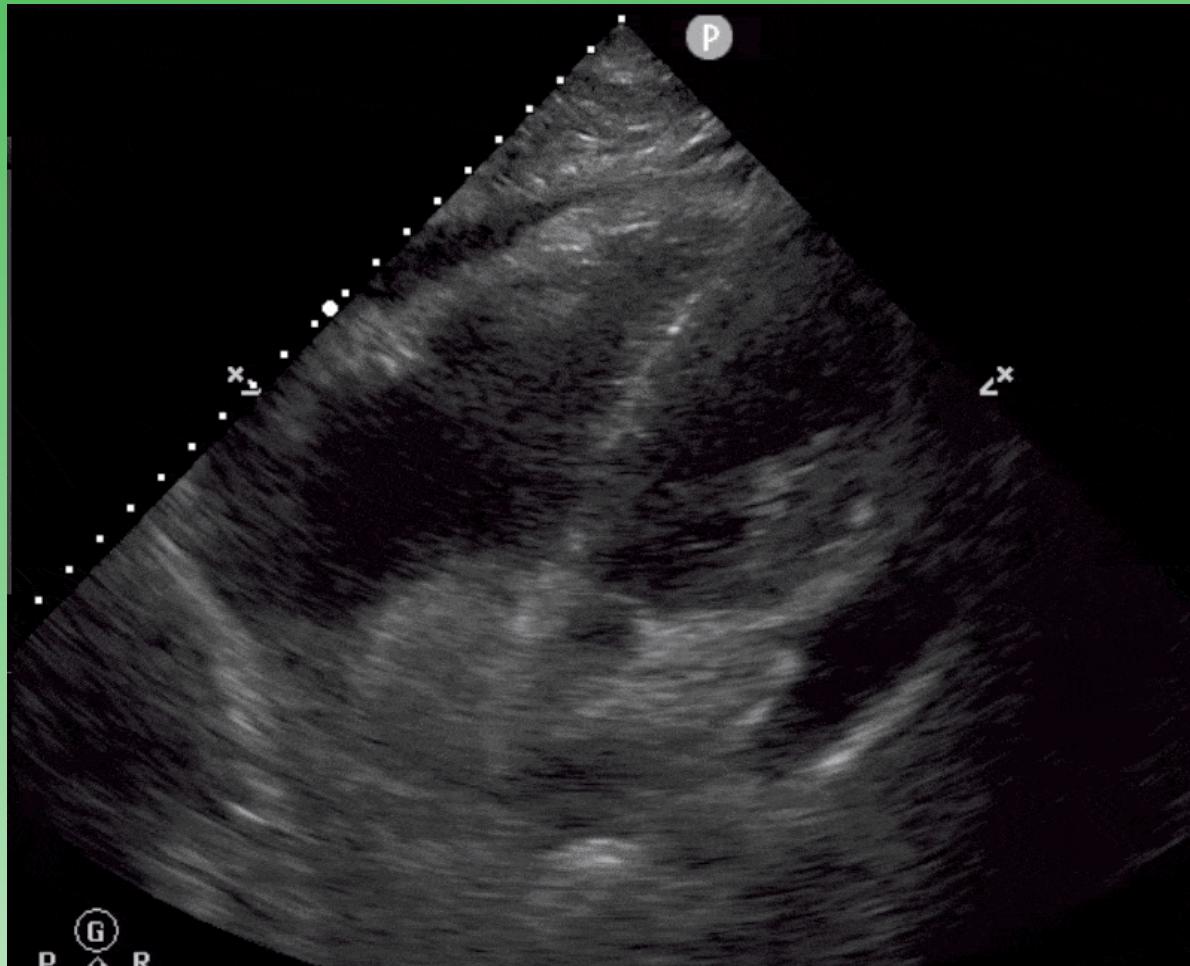


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Pathology Pericardial Effusion

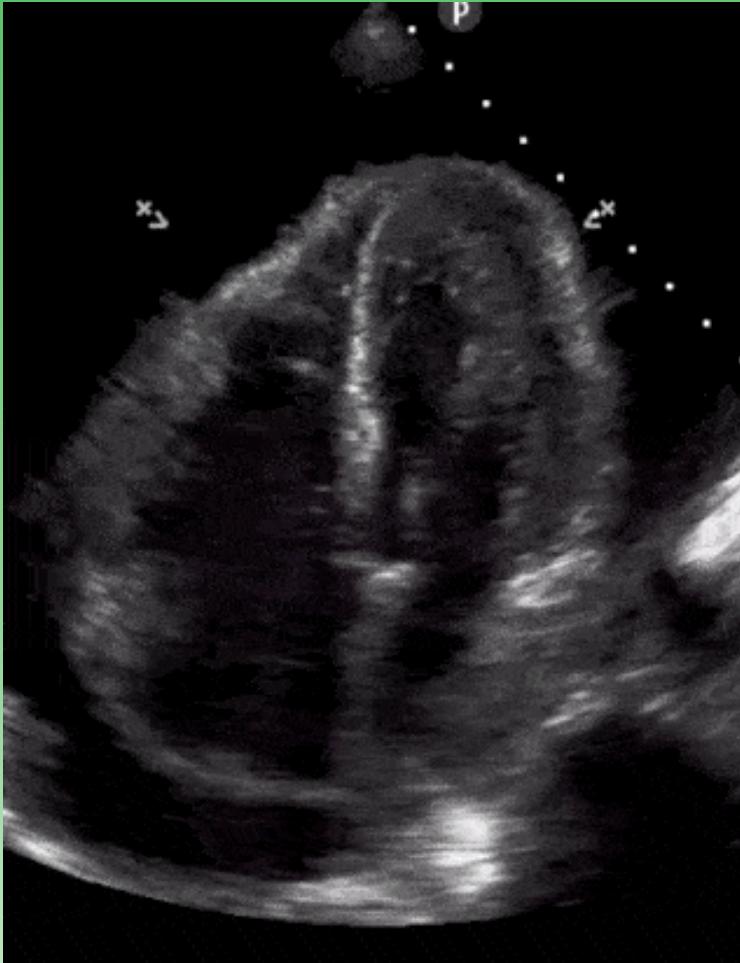


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Pathology Pericardial Effusion



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Lung ultrasound

I. Pleura

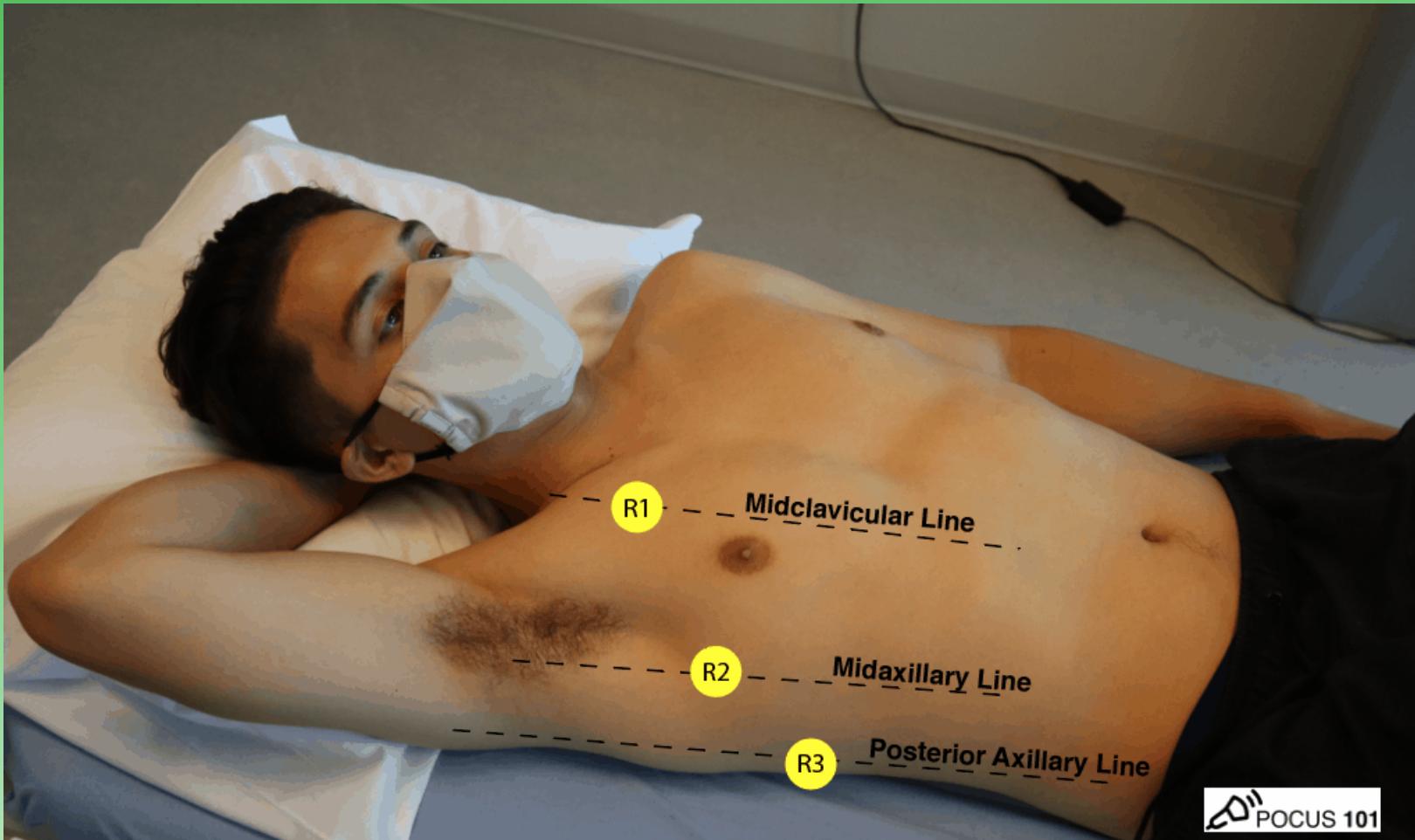
- A. Pneumothorax
- B. ET tube placement

II. Pulmonary edema

III. Pleural effusion

IV. Pneumonia/atelectasis

Lung ultrasound

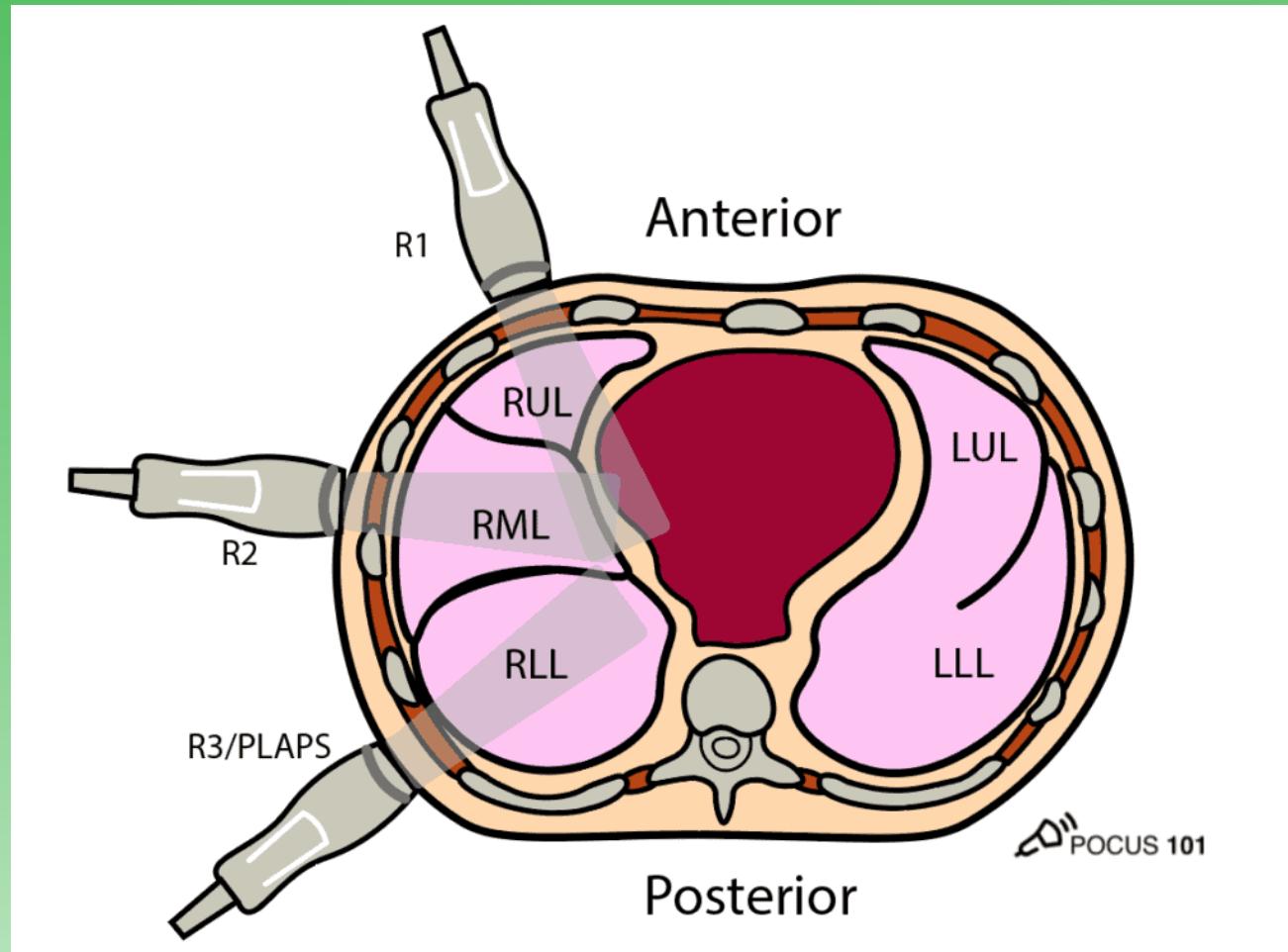


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Lung ultrasound



Lung L/R 1

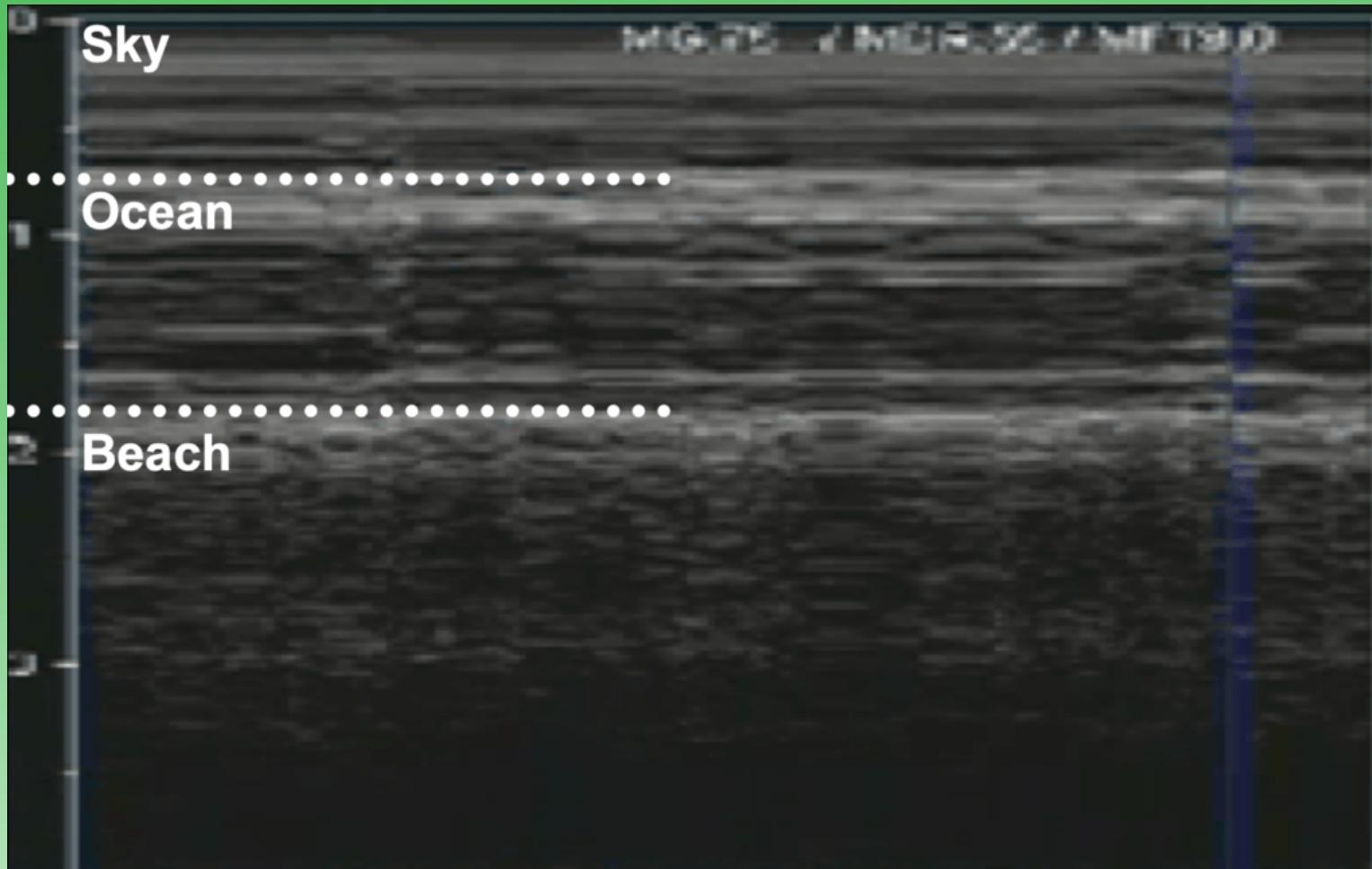


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Lung L/R 1 M Mode



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Lung L/R 3/ PLAPS

L3/Left PLAPS

Diaphragm

Spleen

L Kidney

Lung

(mirror artifact)

Spine

R3/Right PLAPS

Liver

Diaphragm

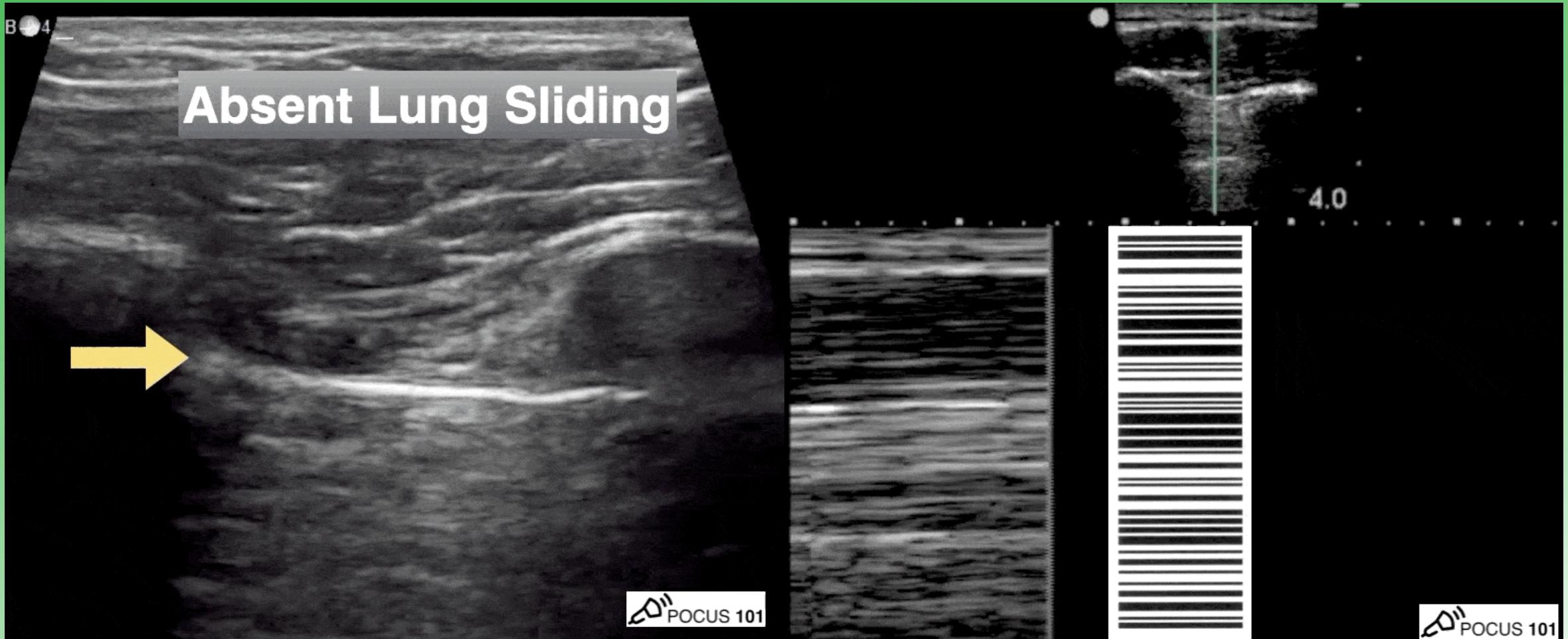
R Kidney

Spine

Lung

(mirror artifact)

Pathology lung sliding



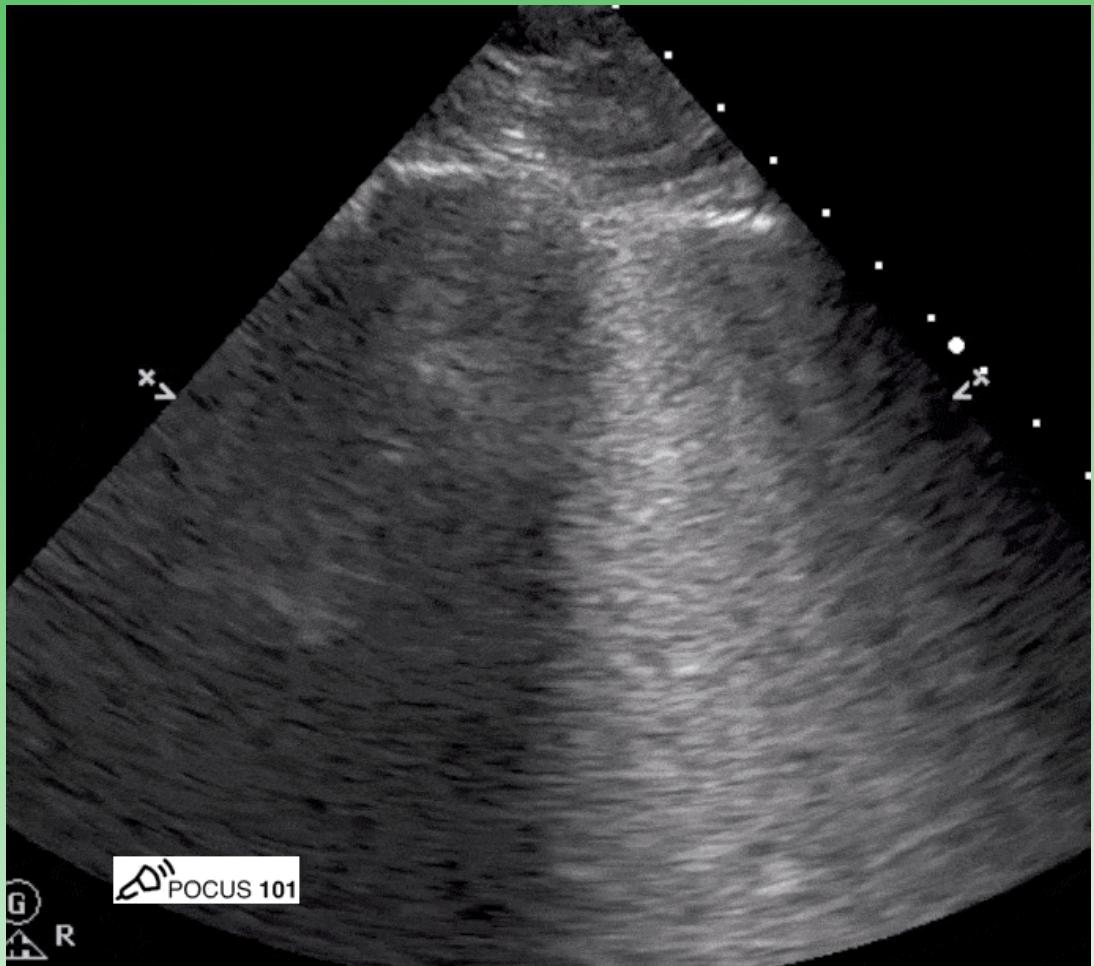
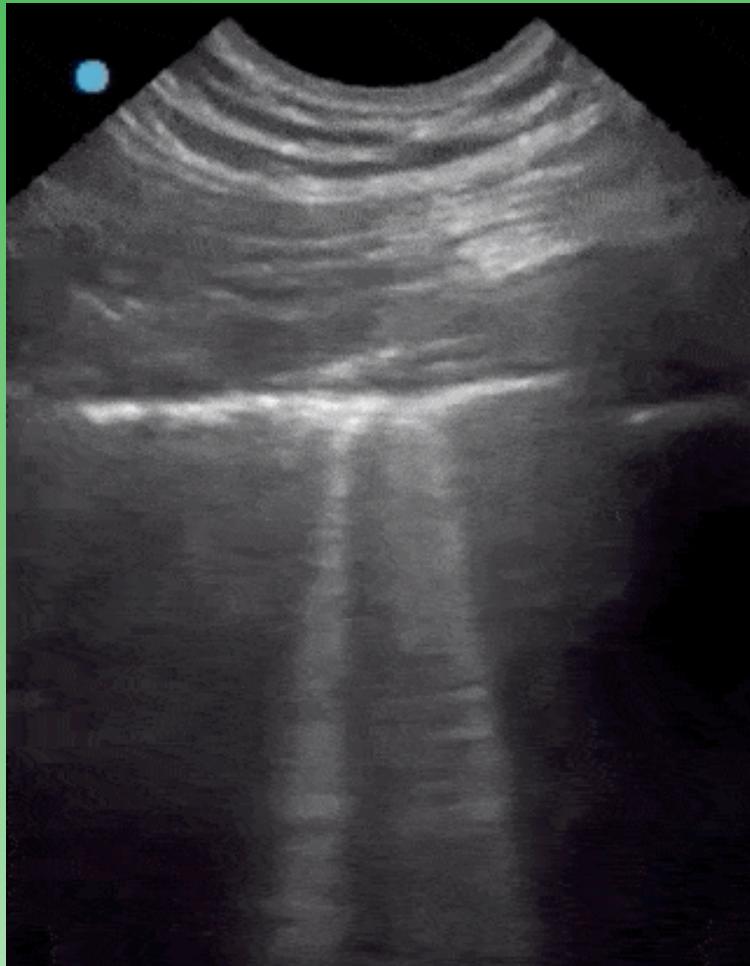
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Pathology B Lines

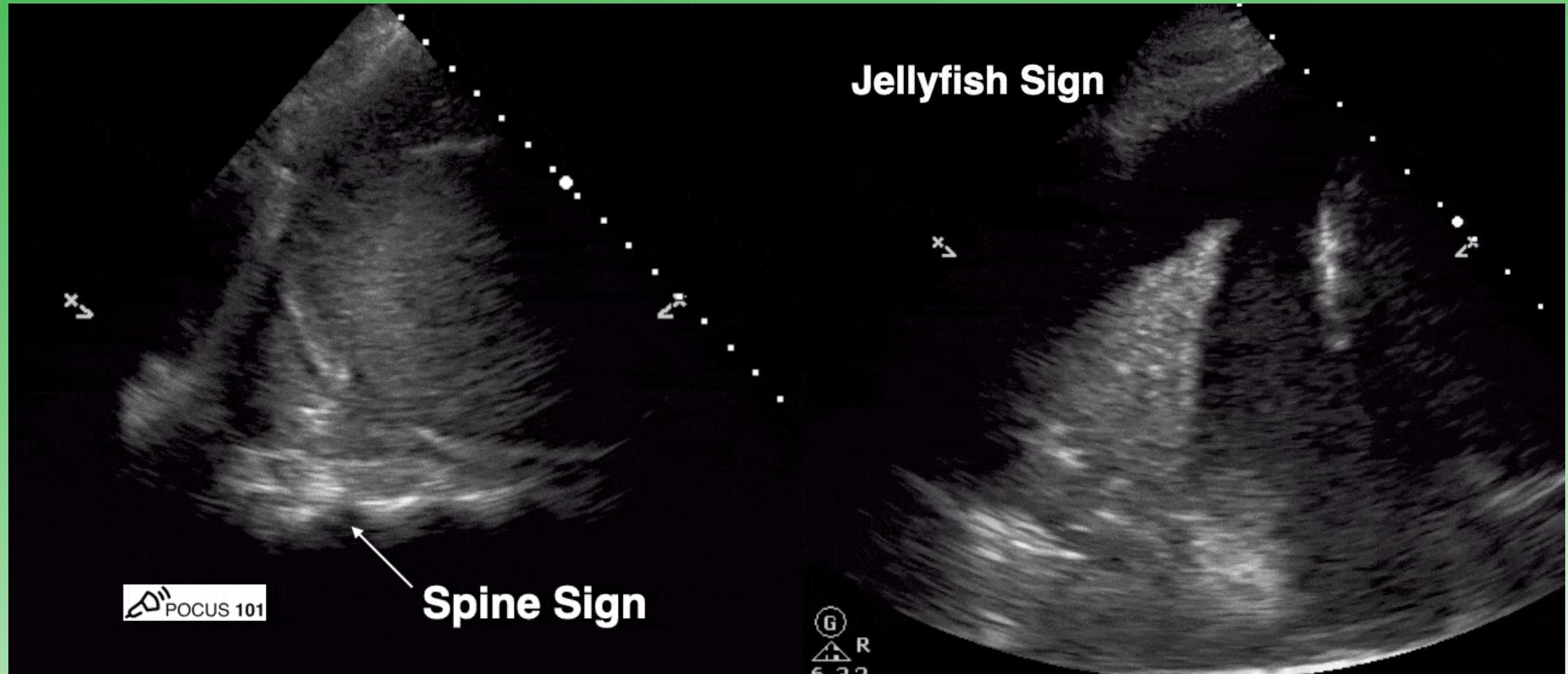


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Pathology PLAPS

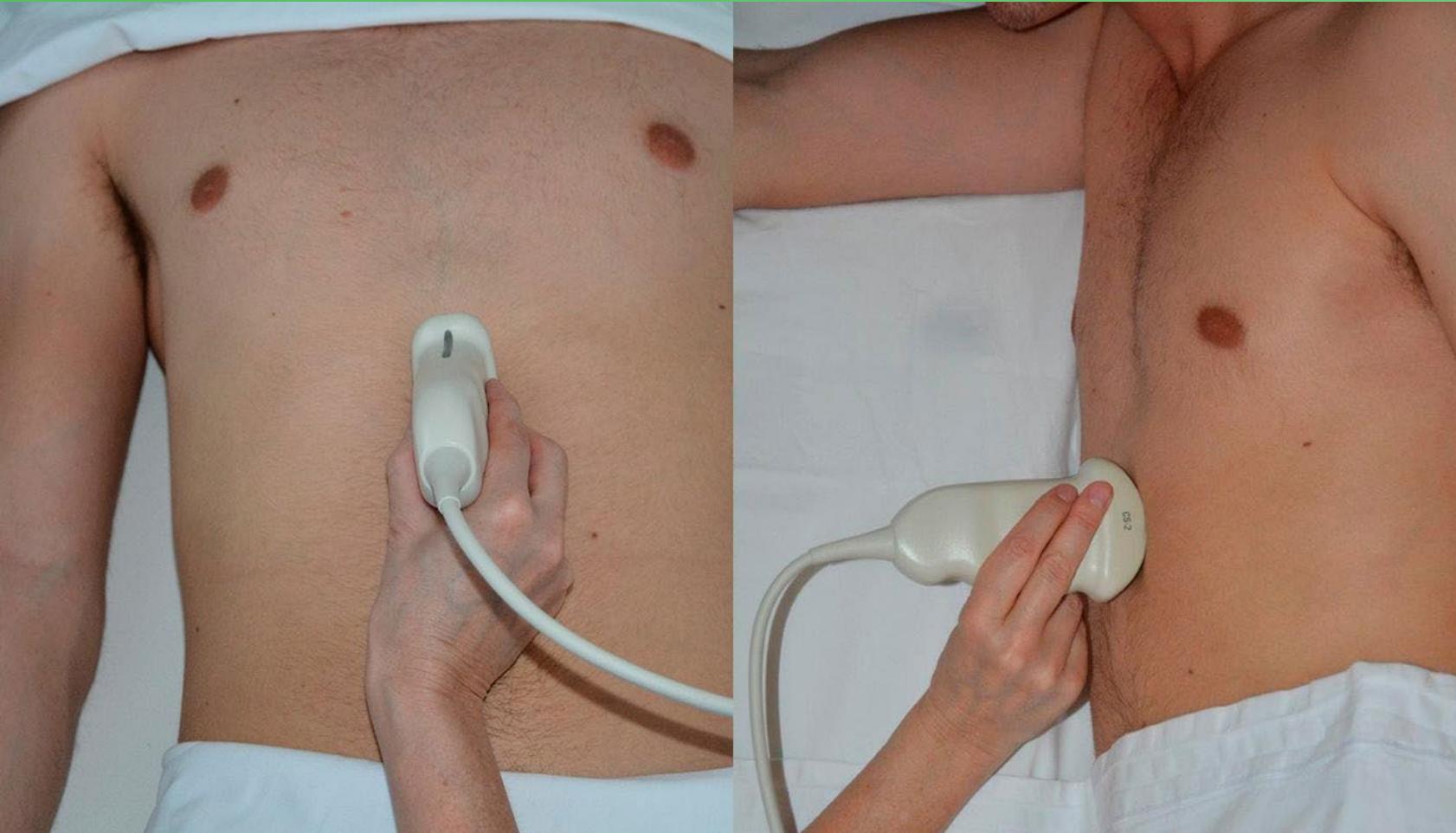


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Gastric Ultrasound

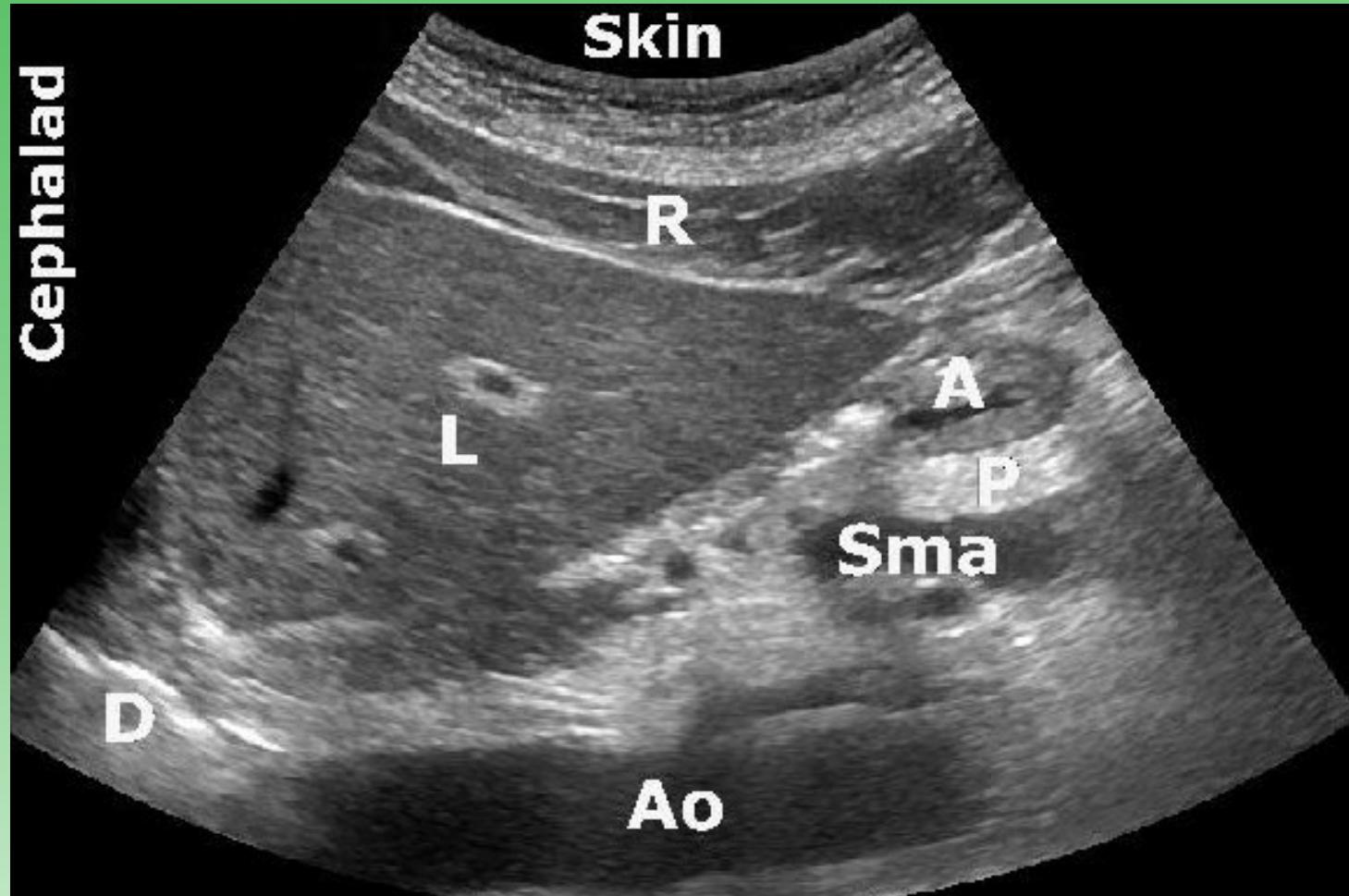
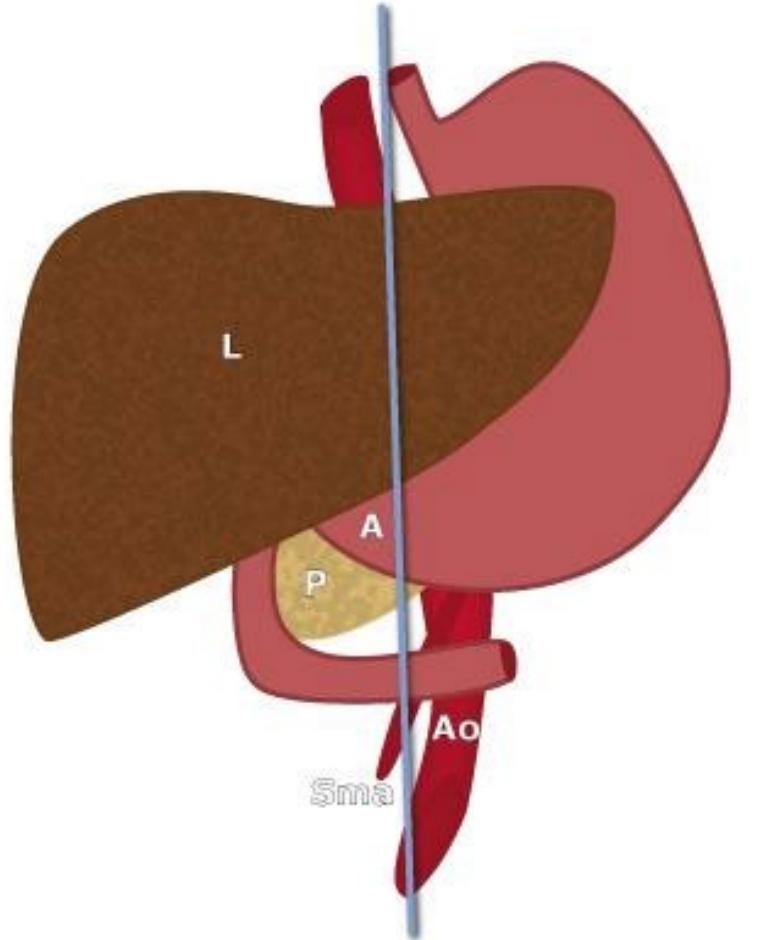


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Gastric Ultrasound

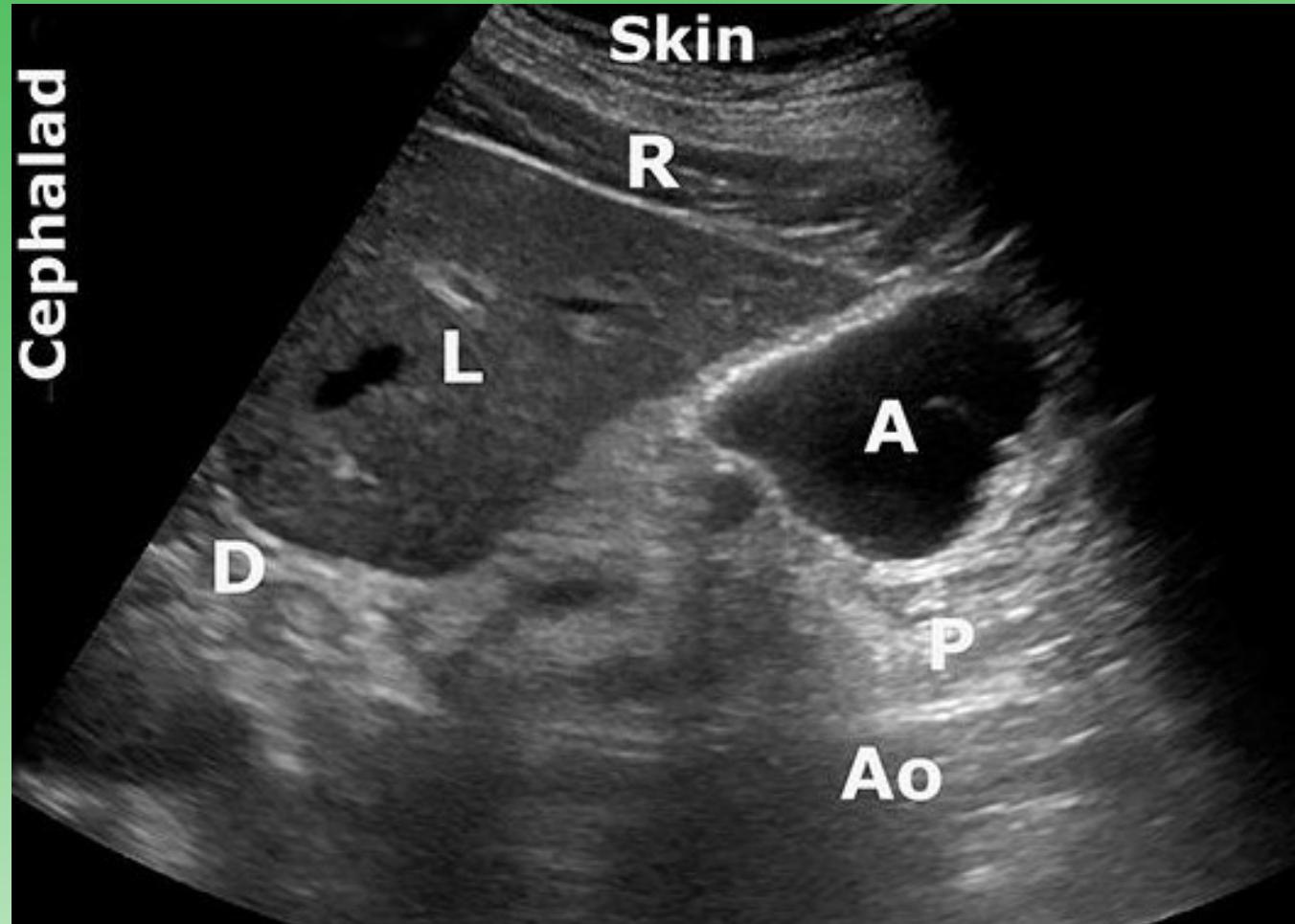


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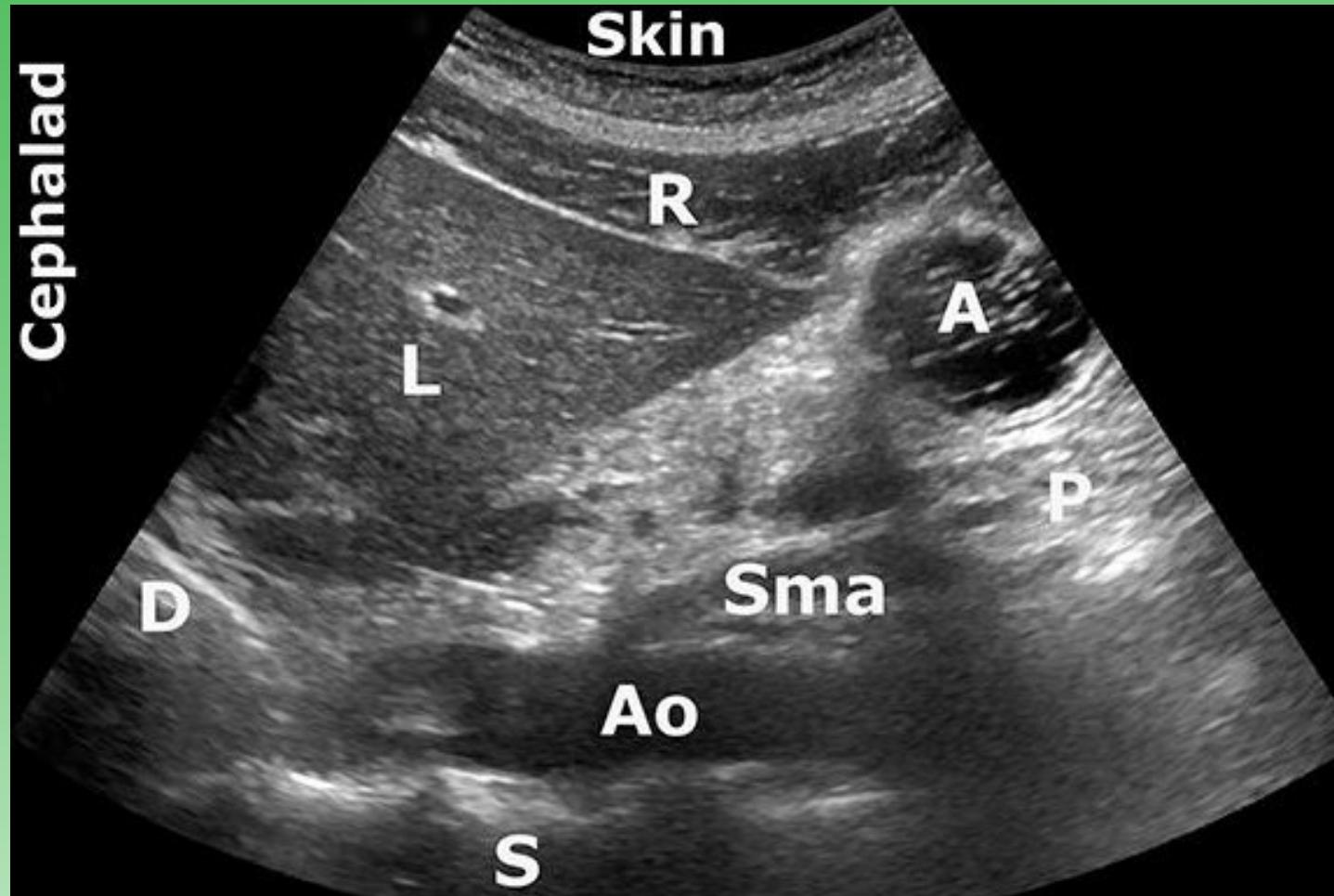


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Fluids



Fluids

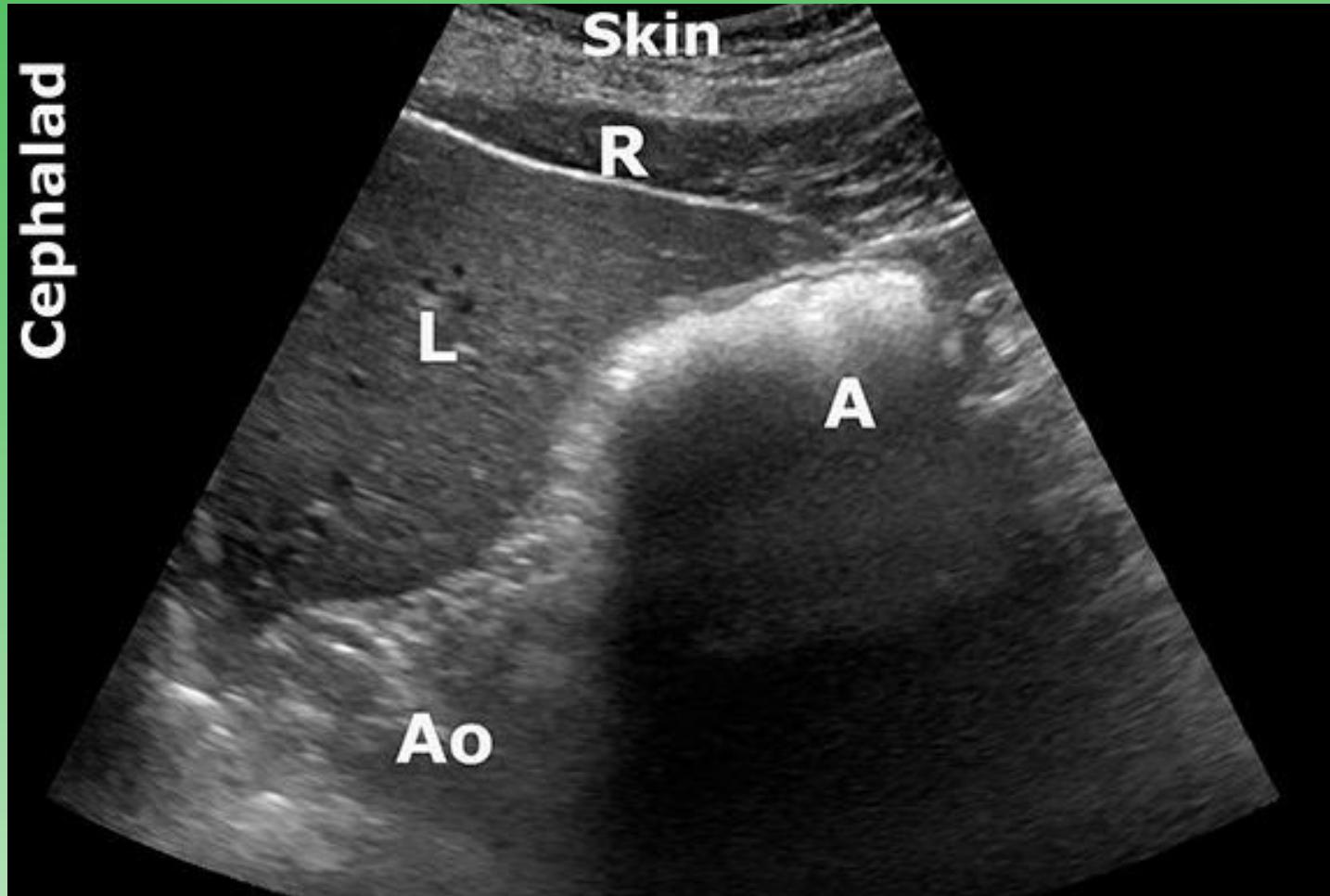


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Early Solids



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Late Solids

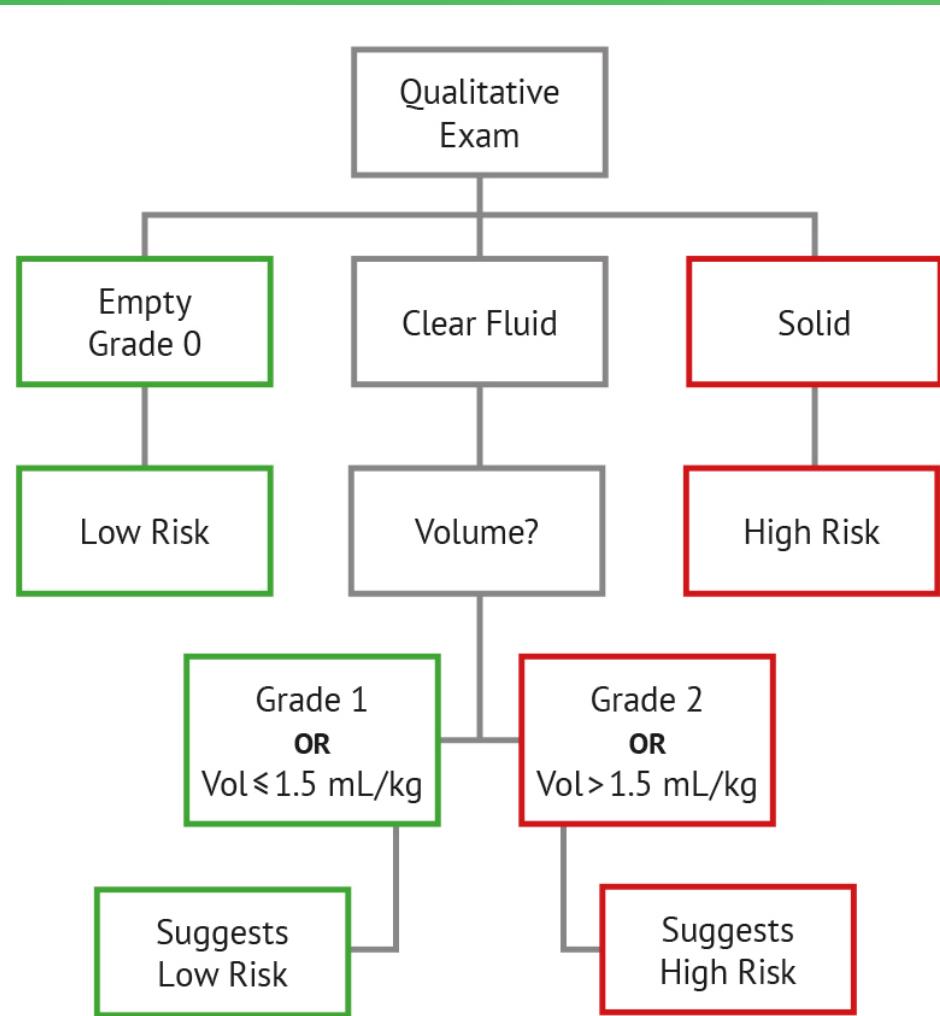


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Evaluation



Right lat CSA (cm ²)	Age(y)							
	20	30	40	50	60	70	80	
2	31	18	5	0	0	0	0	
3	45	32	20	7	0	0	0	
4	60	47	34	21	9	0	0	
5	74	62	49	36	23	10	0	
6	89	76	63	51	38	25	12	
7	103	91	78	65	52	40	27	
8	118	105	93	80	67	54	41	
9	133	120	107	94	82	69	56	
10	147	135	122	109	96	83	71	
11	162	149	136	123	111	98	85	
12	177	164	151	138	125	113	100	
13	191	178	165	153	140	127	114	
14	206	193	180	167	155	142	129	
15	220	207	194	182	169	156	143	
16	235	222	209	200	184	171	158	
17	249	236	224	211	198	185	173	
18	264	251	239	226	213	200	187	
19	278	266	253	240	227	214	202	
20	293	281	268	255	242	229	217	
21	307	295	282	269	256	244	231	
22	323	310	297	284	271	259	246	
23	337	324	311	298	285	273	260	
24	352	339	326	313	301	288	275	
25	366	353	340	327	315	302	289	
26	381	368	355	343	330	317	304	
27	395	382	369	357	344	331	318	
28	410	397	385	372	359	346	333	
29	424	411	398	386	373	360	347	
30	439	427	414	401	388	375	363	

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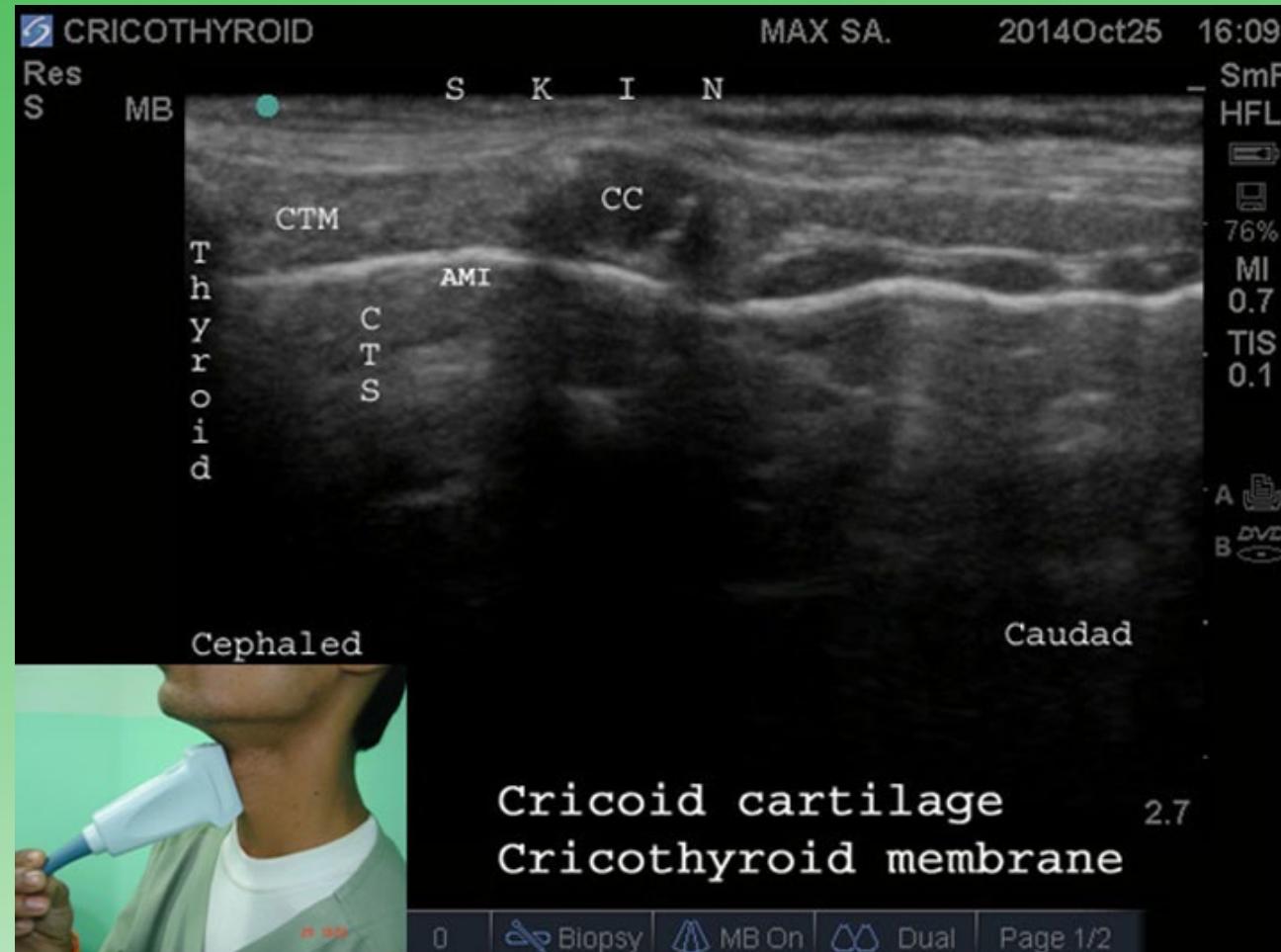


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Evaluation

GRADE	ANTRAL PRESENTATION	VOLUME IMPLICATIONS	ASPIRATION RISK
0	Empty in both supine and RLD position	Minimal	Low risk
1	Empty in supine, clear fluid visible in the RLD	$\leq 1.5 \text{ mL/kg}$, compatible with baseline gastric secretions	Low risk
2	Clear fluid visible in both positions	$> 1.5 \text{ mL/kg}$, likely in excess of baseline gastric secretions	High risk

Airway

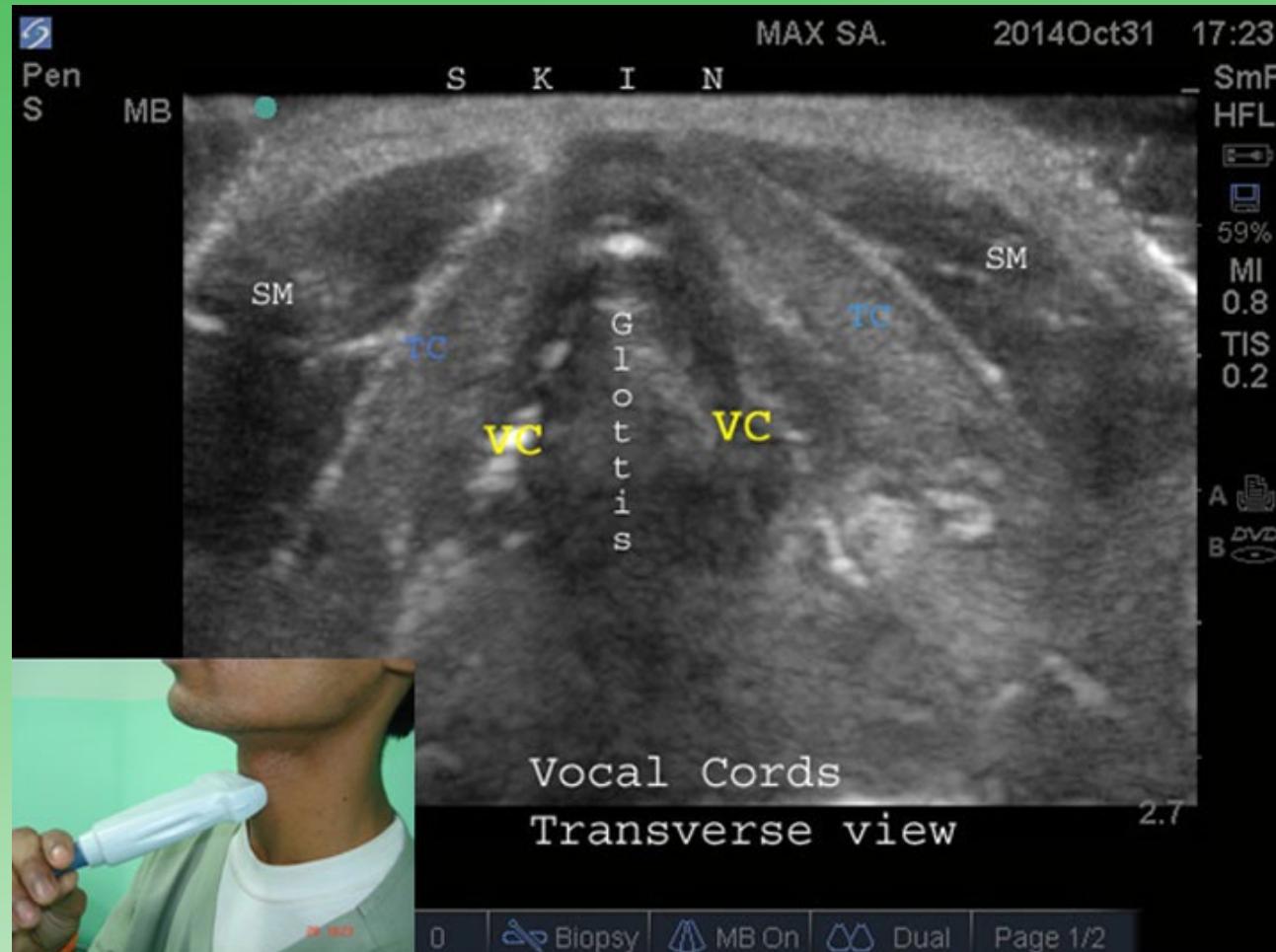


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Airway

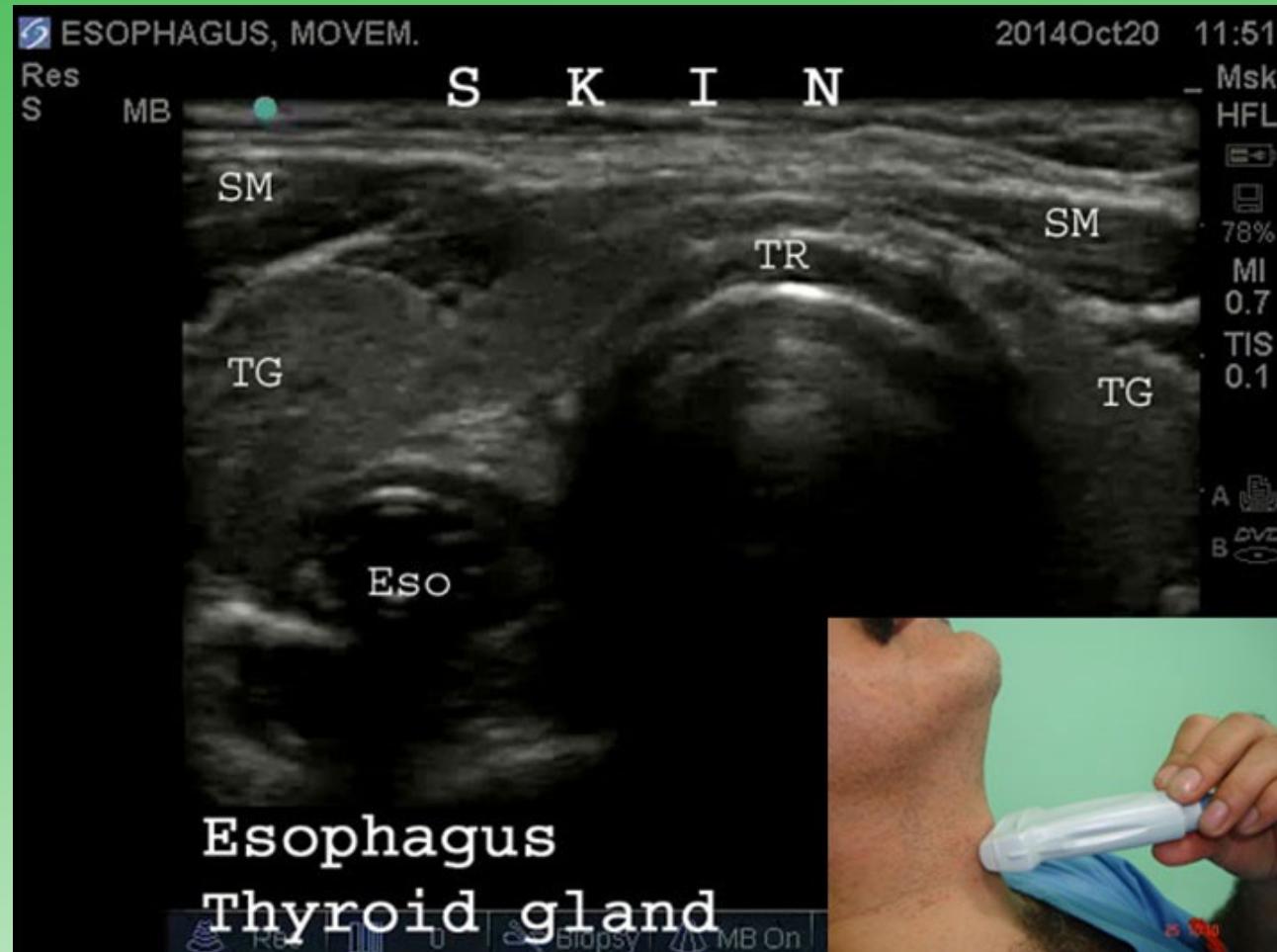


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Airway



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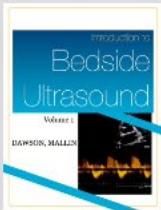


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References



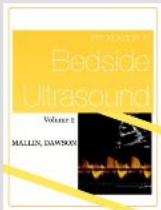
Comprehensive Critical Care Ultrasound



Introduction to Bedside Ultrasound: Volume 1

Matthew Dawson & Mike Mallin

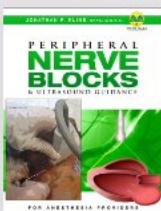
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Introduction to Bedside Ultrasound: Volume 2

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Peripheral Nerve Blocks and Ultrasound Guidanc...

Jonathan P. Kline, CRNA, M.S.N.A.

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